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UGC NET Environmental Science
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NODIA EDITIONS LLP
125, Sector 6, Vidyadhar Nagar, Jaipur 302039
Phone :+91 9024037387
email : mail@nodia.in

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CONTENTS

Chap 01.	Fundamentals of Environmental Sciences	15-89
Chap 02.	Environmental Chemistry	90-162
Chap 03.	Environmental Biology	163-234
Chap 04.	Environmental Geosciences	235-308
Chap 05.	Energy and Environment	309-391
Chap 06.	Environmental Pollution and Control	392-460
Chap 07.	Solid and Hazardous Waste Management	461-538
Chap 08.	Environmental Assessment, Management and Legislation	539-620
Chap 09.	Statistical Approaches and Modelling in Environmental Sciences	621-694
Chap 10.	Contemporary Environmental Issues	695-773

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UNIVERSITY GRANTS COMMISSION
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NET SYLLABUS

Subject : ENVIRONMENTAL SCIENCES **Code No.: (89)**

This syllabus contains ten units:

Unit-I: Fundamentals of Environmental Sciences

Unit-II: Environmental Chemistry

Unit-III: Environmental Biology

Unit-IV: Environmental Geosciences

Unit-V: Energy and Environment

Unit-VI: Environmental Pollution and Control

Unit-VII: Solid and Hazardous Waste Management

Unit-VIII: Environmental Assessment, Management and Legislation

Unit-IX: Statistical Approaches and Modelling in Environmental Sciences

Unit-X: Contemporary Environmental Issues

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Unit-I: Fundamentals of Environmental Sciences

Definition, Principles and Scope of Environmental Science.

Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.

Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance.

Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate. Wind roses.

Interaction between Earth, Man and Environment. Biogeographic provinces of the world and agro-climatic zones of India. Concept of sustainable development.

Natural resources and their assessment. Remote Sensing and GIS: Principles of remote sensing and GIS. Digital image processing and ground truthing. Application of remote sensing and GIS in land cover/land use planning and management (urban sprawling, vegetation study, forestry, natural resource), waste management and climate change.

Environmental education and awareness. Environmental ethics.

Unit-II: Environmental Chemistry

Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.

Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.

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Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).

Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur.

Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O_3, PAN, VOC and POP. Carcinogens in the air.

Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM.

Unit-III: Environmental Biology

Ecology as an inter-disciplinary science. Origin of life and speciation. Human Ecology and Settlement.

Ecosystem Structure and functions: Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems, energy flow models, food chains and food webs. Biogeochemical cycles, Ecological succession. Species diversity, Concept of ecotone, edge effects, ecological habitats and niche. Ecosystem stability and factors affecting stability. Ecosystem services.

Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.

Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain forest.

Population ecology: Characteristics of population, concept of carrying capacity, population growth and regulations. Population fluctuations, dispersion and metapopulation. Concept of ‘r’ and ‘k’ species. Keystone species.

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Community ecology: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions.

Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of 'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: *in situ*, *ex situ* and *in vitro* conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts of gene pool, biopiracy and bio-prospecting. Concept of restoration ecology. Extinct, Rare, Endangered and Threatened flora and fauna of India.

Concept of Industrial Ecology.

Toxicology and Microbiology: Absorption, distribution and excretion of toxic agents, acute and chronic toxicity, concept of bioassay, threshold limit value, margin of safety, therapeutic index, biotransformation. Major water borne diseases and air borne microbes.

Environmental Biotechnology: Bioremediation – definition, types and role of plants and microbes for *in situ* and *ex situ* remediation. Bioindicators, Biofertilizers, Biofuels and Biosensors.

Unit-IV: Environmental Geosciences

Origin of earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere. Concept of minerals and rocks. Formation of igneous and metamorphic rocks. Controls on formation of landforms - tectonic including plate tectonic and climatic. Concept of steady state and equilibrium, Energy budget of the earth. Earth's thermal environment and seasons. Coriolis force, pressure gradient force, frictional force, geo-strophic wind field, gradient wind. Climates of India, western disturbances, Indian monsoon, droughts, *El Nino*, *La Nina*. Concept of residence time and rates of natural cycles. Geophysical fields.

Weathering including weathering reactions, erosion, transportation and deposition of sediments. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and

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chemical properties, soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.

Geochemical classification of elements, abundance of elements in bulk earth, crust, hydrosphere and biosphere. Partitioning of elements during surficial geologic processes, Geochemical recycling of elements. Paleoclimate.

Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity, groundwater tracers, land subsidence, effects of excessive use of groundwater, groundwater quality. Pollution of groundwater resources, Ghyben-Herzberg relation between fresh-saline water.

Natural resource exploration and exploitation and related environmental concerns. Historical perspective and conservation of non-renewable resources.

Natural Hazards: Catastrophic geological hazards - floods, landslides, earthquakes, volcanism, avalanche, tsunami and cloud bursts. Prediction of hazards and mitigation of their impacts.

Unit-V: Energy and Environment

Sun as source of energy; solar radiation and its spectral characteristics. Fossil fuels: classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas. Shale oil, Coal bed Methane, Gas hydrates. Gross-calorific value and net-calorific value.

Principles of generation of hydro-power, tidal energy, ocean thermal energy conversion, wind power, geothermal energy, solar energy (solar collectors, photo-voltaic modules, solar ponds).

Nuclear energy - fission and fusion, Nuclear fuels, Nuclear reactor – principles and types.

Bioenergy: methods to produce energy from biomass.

Environmental implications of energy use; energy use pattern in India and the world, emissions of CO_2 in developed and developing countries

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including India, radiative forcing and global warming. Impacts of large scale exploitation of solar, wind, hydro and nuclear energy sources.

Unit-VI: Environmental Pollution and Control

Air Pollution:

Sources and types of Pollutants – Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Control devices for particulate matter: Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.

Noise Pollution:

Sources, weighting networks, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, L_{DN}, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health.

Water Pollution:

Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.

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Soil Pollution:
Physico-chemical and biological properties of soil (texture, structure, inorganic and organic components). Analysis of soil quality. Soil Pollution control. Industrial effluents and their interactions with soil components. Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers.

Thermal, Marine Pollution and Radioactive:
Sources of Thermal Pollution, Heat Islands, causes and consequences. Sources and impact of Marine Pollution. Methods of Abatement of Marine Pollution. Coastal management. Radioactive pollution – sources, biological effects of ionizing radiations, radiation exposure and radiation standards, radiation protection.

Unit-VII: Solid and Hazardous Waste Management

Solid Waste - types and sources. Solid waste characteristics, generation rates, solid waste components, proximate and ultimate analyses of solid wastes.

Solid waste collection and transportation: container systems - hauled and stationary, layout of collection routes, transfer stations and transportation.

Solid waste processing and recovery – Recycling, recovery of materials for recycling and direct manufacture of solid waste products. Electrical energy generation from solid waste (Fuel pellets, Refuse derived fuels), composting and vermicomposting, biomethanation of solid waste. Disposal of solid wastes – sanitary land filling and its management, incineration of solid waste.

Hazardous waste – Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.

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e-waste: classification, methods of handling and disposal.

Fly ash: sources, composition and utilisation.

Plastic waste: sources, consequences and management.

Unit-VIII: Environmental Assessment, Management and Legislation

Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). EIA Guidelines. Impact Assessment Methodologies. Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost-benefit analysis. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO14000 series). EIA Notification, 2006 and amendments from time to time. Eco-labeling schemes.

Risk Assessment - Hazard identification, Hazard accounting, Scenarios of exposure, Risk characterization and Risk management.

Overview of Environmental Laws in India: Constitutional provisions in India (Article 48A and 51A). Wildlife Protection Act, 1972 amendments 1991, Forest Conservation Act, 1980, Indian Forest Act, Revised 1982, Biological Diversity Act, 2002, Water (Prevention and Control of Pollution) Act, 1974 amended 1988 and Rules 1975, Air (Prevention and Control of Pollution) Act, 1981 amended 1987 and Rules 1982, Environmental (Protection) Act, 1986 and Rules 1986, Motor Vehicle Act, 1988, The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation

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and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP.

Unit-IX: Statistical Approaches and Modelling in Environmental Sciences

Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Basic concept of probability theory, Sampling theory, Distributions - Normal, log-normal, Binomial, Poisson, t, χ^2 and F-distribution. Correlation, Regression, tests of hypothesis (t-test, χ^2-test ANOVA: one-way and two-way); significance and confidence limits.

Approaches to development of environmental models; linear, simple and multiple regression models, validation and forecasting. Models of population growth and interactions: Lotka-Voltera model, Leslie's matrix model.

Unit-X: Contemporary Environmental Issues

Global Environmental Issues – Biodiversity loss, Climate change, Ozone layer depletion. Sea level rise. International efforts for environmental protection.

National Action Plan on Climate Change (Eight National missions – National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a

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‘Green India’, National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change).

Current Environmental Issues in India: Environmental issues related to water resource projects - Narmada dam, Tehri dam, Almatti dam, Cauvery and Mahanadi, Hydro-power projects in Jammu & Kashmir, Himachal and North-Eastern States.

Water conservation-development of watersheds, Rain water harvesting and ground water recharge.

National river conservation plan – Namami Gange and Yamuna Action Plan.

Eutrophication and restoration of lakes. Conservation of wetlands, Ramsar sites in India.

Soil erosion, reclamation of degraded land, desertification and its control.

Climate change - adaptability, energy security, food security and sustainability.

Forest Conservation – Chipko movement, Appiko movement, Silent Valley movement and Gandhamardhan movement. People Biodiversity register.

Wild life conservation projects: Project tiger, Project Elephant, Crocodile Conservation, GOI-UNDP Sea Turtle project, Indo-Rhino vision.

Carbon sequestration and carbon credits.

Waste Management – Swachha Bharat Abhiyan.

Sustainable Habitat: Green Building, GRIHA Rating Norms.

Vehicular emission norms in India.

Epidemiological Issues: Fluorosis, Arsenocosis, Goitre, Dengue.

Environmental Disasters: Minnamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011.

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CHAPTER 01

Fundamentals of Environmental Sciences

1. Which of the following best defines Environmental Science?
(A) The study of living organisms in isolation from their habitats.
(B) The scientific study of our environment and our role in it.
(C) The specialized study of chemical pollutants in the atmosphere.
(D) The study of geological formations and Earth's rock cycles.

2. The principle that suggests environmental issues should be viewed as a whole, encompassing all their interacting parts, is known as:
(A) The Principle of Holism
(B) The Principle of Reductionism
(C) The Principle of Anthropocentrism
(D) The Principle of Uniformitarianism

3. Given below are two statements:
Statement I : The scope of Environmental Science is limited to only the study of pollution.
Statement II : Environmental Science is an interdisciplinary field, drawing from natural sciences, social sciences, and humanities.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct, but Statement II is incorrect.
(D) Statement I is incorrect, but Statement II is correct.

4. The layer of the atmosphere closest to the Earth's surface, where most weather phenomena occur, is the:
(A) Stratosphere
(B) Mesosphere
(C) Thermosphere
(D) Troposphere

5. Which gas is the most abundant in the Earth's atmosphere by volume?
(A) Oxygen
(B) Argon
(C) Nitrogen
(D) Carbon Dioxide

6. Which of the following is an INCORRECT statement regarding the structure of the atmosphere?
(A) The troposphere is characterized by a general decrease in temperature with increasing altitude.
(B) Temperature increases with altitude throughout the mesosphere.
(C) The ozone layer is primarily located in the stratosphere.
(D) The thermosphere is the outermost layer, characterized by very high temperatures.

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7. Match List I with List II.
List I: (Sphere of Earth)
P. Hydrosphere
Q. Lithosphere
R. Atmosphere
S. Biosphere
List II: (Primary Component)
1. Rocks and soil
2. Living organisms
3. Gases and aerosols
4. Water in all forms
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

8. The First Law of Thermodynamics, as applied to environmental systems, is fundamentally a statement of:
(A) The conservation of energy
(B) The increase in entropy
(C) The law of mass action
(D) The conservation of momentum

9. The transfer of heat through the movement of a fluid (liquid or gas) is known as:
(A) Conduction
(B) Radiation
(C) Convection
(D) Advection

10. The Second Law of Thermodynamics implies that in any energy conversion process:
(A) Some energy is always lost as low-quality heat.
(B) Energy is created from nothing in the system.
(C) The total entropy of an isolated system decreases.
(D) 100% efficiency in energy transfer is achievable.

11. Consider the following statements regarding the spheres of the Earth:
(a) The hydrosphere includes all water on Earth, including that in the atmosphere.
(b) The lithosphere is a rigid layer composed of the crust and the upper part of the mantle.
(c) The biosphere is completely independent and does not interact with the other spheres.
(d) The atmosphere's composition has remained constant throughout Earth's history.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (b) and (c) only
(C) (a), (b), and (d)
(D) (c) and (d) only

12. A company's factory releases a certain amount of pollutant into a river. To determine the concentration of the pollutant downstream, an environmental scientist would apply the principle of:
(A) The Second Law of Thermodynamics
(B) Material Balance
(C) Adiabatic Lapse Rate
(D) Environmental Ethics

13. What term describes the amount of water vapor present in the air, expressed as grams of water vapor per kilogram of dry air?
(A) Relative humidity
(B) Dew point
(C) Mixing ratio
(D) Precipitation

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14. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The temperature in the stratosphere generally increases with altitude.
Reason (R) : The presence of the ozone layer in the stratosphere absorbs ultraviolet (UV) radiation from the sun, causing warming.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

15. The rate at which an unsaturated parcel of dry air cools as it rises through the atmosphere is called the:
(A) Adiabatic Lapse Rate (ALR)
(B) Environmental Lapse Rate (ELR)
(C) Saturation Mixing Ratio
(D) Geothermal Gradient

16. If the Environmental Lapse Rate (ELR) is greater than the Adiabatic Lapse Rate (ALR), the atmosphere is considered to be:
(A) Stable
(B) Unstable
(C) Neutral
(D) Inverted

17. A wind rose is a graphical tool used in meteorology to primarily display:
(A) Temperature and pressure variations over time.
(B) Wind speed and wind direction at a specific location.
(C) The saturation point of air at different altitudes.
(D) The amount and type of precipitation at the site.

18. Consider the following layers of the atmosphere:
(a) Mesosphere
(b) Troposphere
(c) Thermosphere
(d) Stratosphere
Which of the following is the correct order starting from the Earth's surface?
(A) (b), (a), (d), (c)
(B) (b), (d), (a), (c)

(C) (a), (c), (b), (d)
(D) (d), (b), (c), (a)

19. The concept of Sustainable Development was brought into common use by which of the following?
(A) The 1997 Kyoto Protocol on global greenhouse gas emissions.
(B) The 1992 United Nations Conference on Environment and Development.
(C) The Brundtland Commission Report ('Our Common Future').
(D) The Stockholm Conference on the Human Environment of 1972

20. Which of the following is NOT one of the three core pillars of sustainable development?
(A) Environmental protection
(B) Social equity
(C) Economic viability
(D) Political stability

21. Identify the INCORRECT pair.
(A) Lithosphere - Rocks and minerals
(B) Hydrosphere - Oceans and rivers
(C) Biosphere - Only non-living components
(D) Atmosphere - Ozone and Nitrogen

22. The interaction between man and environment has been historically viewed from different perspectives. The perspective that human beings are the most significant entity in the universe and that nature is for human use is termed:
(A) Ecocentrism
(B) Anthropocentrism
(C) Biocentrism
(D) Holism

23. The agro-climatic zones of India are primarily classified based on:
(A) Political boundaries and local population density levels.
(B) Regional industrial development and patterns of urbanization.
(C) Historical territories and distinct cultural heritage regions.
(D) Rainfall, temperature, and specific soil characteristics.

24. Which of the following statements about the principles of remote sensing is correct?
(A) It detects electromagnetic radiation reflected or emitted from an object.
(B) It involves maintaining direct physical contact with the object studied.
(C) Passive systems incorporate their own internal source of illumination.
(D) It is only capable of capturing images within the visible spectrum range.

25. Consider the following statements about GIS:
(a) GIS is a system for capturing, storing, and displaying only geographical maps.
(b) Raster and vector are the two primary data models used in GIS.
(c) GIS can be used to perform spatial analysis to find patterns and relationships.
(d) Ground truthing is not a necessary component for GIS-based analysis.
(e) GIS integrates hardware, software, data, people, and methods.
Which of the above statement(s) is/are correct?
(A) (a), (c), and (d) only
(B) (b), (c), and (e) only
(C) (a), (b), and (e) only
(D) (c), (d), and (e) only

26. In the context of Geographic Information Systems (GIS), what is 'ground truthing'?
(A) The collection of ground-level data to verify remote sensing information.
(B) The systematic process of converting traditional paper maps to digital formats.
(C) A specific software algorithm used for correcting complex image distortions.
(D) The foundational database layer representing the physical surface of the Earth.

27. Digital Image Processing (DIP) in the context of remote sensing is used for:
(A) Manufacturing the sensors for satellites.
(B) Transmitting data from the satellite to the ground station.
(C) Physically collecting samples from the target area.
(D) Enhancing and classifying satellite images to extract information.

28. Given below are two statements:
Statement I : Environmental education aims to increase public awareness and knowledge of

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environmental issues.
Statement II : Environmental ethics is a branch of philosophy that studies the moral relationship of human beings to the environment.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct, but Statement II is incorrect.
(D) Statement I is incorrect, but Statement II is correct.

29. The ethical viewpoint that extends moral standing to all living beings, not just humans, is known as:
(A) Anthropocentrism
(B) Technocentrism
(C) Biocentrism
(D) Androcentrism

30. Which of the following is a primary application of remote sensing and GIS in urban planning?
(A) Determining the chemical composition of city smog.
(B) Calculating the exact population of a city in real-time.
(C) Regulating traffic signals dynamically based on flow.
(D) Monitoring and analyzing urban sprawling over time.

31. Match List I with List II.
List I: (Meteorological Parameter)
P. Pressure
Q. Wind Velocity
R. Precipitation
S. Radiation
List II: (Unit of Measurement)
1. mm or cm
2. Watts/m^2
3. knots or m/s
4. Pascal or millibar
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-4, S-1

32. The term mass and energy transfer across various interfaces refers to processes occurring between which of the following?
(A) Only between the various distinct layers within the Earth's atmosphere.
(B) Between systems like air-water, water-sediment, and soil-air interfaces.
(C) Only across the political borders and boundaries of different countries.
(D) Only within the internal core of the Earth and the surrounding mantle.

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33. Which law of thermodynamics explains that energy cannot be created or destroyed, only changed from one form to another?
(A) Zeroth Law of Thermodynamics
(B) First Law of Thermodynamics
(C) Second Law of Thermodynamics
(D) Third Law of Thermodynamics

34. The transfer of heat from the Sun to the Earth occurs primarily through:
(A) Radiation
(B) Conduction
(C) Convection
(D) Advection

35. A material balance equation is based on the principle of:
(A) Conservation of energy
(B) Increase in entropy
(C) Conservation of mass
(D) Economic equilibrium

36. The total amount of water on Earth, in its various forms including oceans, ice caps, groundwater, and atmospheric water, constitutes the:
(A) Lithosphere
(B) Biosphere
(C) Cryosphere
(D) Hydrosphere

37. Consider the following statements about the lithosphere:
(a) It is the solid, outer part of the Earth.
(b) It includes the brittle upper portion of the mantle and the crust.
(c) It is a permanently fixed and static layer.
(d) It is broken up into tectonic plates.
Which of the above statement(s) is/are correct?
(A) (a) and (c) only

(B) (b), (c) and (d)
(C) (a), (b), and (d)
(D) (a) and (d) only

38. The zone of life on Earth, encompassing all ecosystems, is known as the:
(A) Atmosphere
(B) Biosphere
(C) Geosphere
(D) Hydrosphere

39. The term 'agro-climatic zones of India' refers to a classification system that helps in:
(A) Determining international trade policies for various agricultural products.
(B) Dividing modern states based on their specific linguistic demographics.
(C) Mapping the geographic distribution of all valuable mineral resources.
(D) Planning agricultural practices and research suitable for specific regions.

40. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Remote sensing is a valuable tool for monitoring large-scale deforestation.
Reason (R) : Satellite imagery can be used to compare land cover at different points in time, revealing changes in forest area.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

41. In GIS, data representing features with discrete boundaries, such as roads, rivers, or parcels of land, is typically stored using the:
(A) Raster data model
(B) Image data model
(C) Vector data model
(D) Elevation data model

42. What is the most appropriate definition of the saturation mixing ratio?
(A) The ratio of water vapor to dry air when the air is saturated.
(B) The temperature at which air becomes completely saturated.
(C) The total amount of rainfall received over a specific period.
(D) The speed at which water evaporates into the open atmosphere.

43. Which of the following is NOT an application of GIS and remote sensing in waste management?
(A) Identifying geographically suitable sites for new municipal landfills.
(B) Monitoring the spread of toxic leachate from existing waste landfills.
(C) Optimizing logistics and routes for municipal waste collection vehicles.
(D) Directly converting waste into energy within the software environment.

44. Consider the following steps of a typical remote sensing process:
(a) Data Acquisition (by sensor)
(b) Data Processing and Analysis
(c) Energy Source or Illumination
(d) Information Presentation
(e) Transmission, Reception, and Processing
Which of the following is the correct chronological order?
(A) (c), (a), (e), (b), (d)
(B) (a), (c), (e), (d), (b)
(C) (c), (e), (a), (b), (d)
(D) (a), (b), (c), (d), (e)

45. The ethical perspective that values the entire ecosystem, including biotic and abiotic components, is called:
(A) Biocentrism
(B) Anthropocentrism
(C) Ecocentrism
(D) Pathocentrism

46. Environmental education and awareness are crucial for:
(A) Promoting and encouraging unsustainable global consumption patterns.
(B) Actively increasing the current rate of natural resource depletion.
(C) Focusing on scientific research without including broader public involvement.
(D) Fostering skills and motivations to participate in environmental protection.

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47. In the context of a mass balance for a pollutant in a lake, which term would be considered an 'output'?
(A) Outflow through a dam's spillway.
(B) Inflow from a tributary river.
(C) Direct rainfall onto the lake surface.
(D) Runoff from adjacent agricultural land.

48. The standard atmospheric pressure at sea level is approximately:
(A) 500 millibars
(B) 1013.25 millibars
(C) 2015.50 millibars
(D) 100 millibars

49. Which of the following is a key principle of Environmental Science?
(A) Human activities have no significant impact on the environment.
(B) Environmental systems are complex and interconnected.
(C) All environmental problems have simple, single-cause solutions.
(D) Natural resources are infinite and do not require management.

50. The scope of environmental science includes the study of:
(A) The interaction between physical, biological, and cultural elements.
(B) The study of the physical components of the natural environment only.
(C) The study of the biological components of the natural environment only.
(D) The study of the cultural and social aspects of the human environment.

51. Consider the following statements regarding meteorological parameters:
(a) Humidity is a measure of the amount of water vapor in the air.
(b) Precipitation can only occur in the form of rain.
(c) Wind velocity has two components: speed and direction.
(d) Atmospheric pressure always increases with altitude.
(e) Solar radiation is the primary source of energy for Earth's climate system.
Which of the above statement(s) is/are correct?
(A) (a), (c), and (e) only
(B) (b), (d), and (e) only
(C) (a), (b), and (c) only
(D) (c), (d), and (e) only

52. The temperature inversion, a condition where temperature increases with altitude in the troposphere, leads to:
(A) Extremely good visibility conditions.
(B) The rapid dispersal of local pollutants.
(C) The formation of severe thunderstorms.
(D) The trapping of pollutants near the ground.

53. Biogeographic provinces are large areas of the Earth's surface where:
(A) The regional climate is uniformly and precisely the same.
(B) The international political boundaries are clearly defined.
(C) Flora and fauna have a shared and distinct evolutionary history.
(D) Only agricultural activities take place within the region.

54. The most widely accepted definition of sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This definition emphasizes:
(A) Rapid economic growth above all other considerations.
(B) Inter-generational equity.
(C) Complete preservation of nature without any human development.
(D) The supremacy of present needs over those of future generations.

55. Match List I with List II.
List I: (Concept)
P. Anthropocentrism
Q. Biocentrism
R. Ecocentrism
S. Sustainable Development
List II: (Description)
1. Moral value in all living things
2. Balancing present and future needs
3. Moral value in whole ecological systems
4. Human-centered point of view
(A) P-1, Q-4, R-3, S-2
(B) P-4, Q-1, R-3, S-2
(C) P-4, Q-3, R-1, S-2

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(D) P-2, Q-1, R-4, S-3

56. The main objective of environmental education is to:
(A) Develop a population that is aware of and concerned about the environment.
(B) Train specialists exclusively for governmental pollution control boards.
(C) Encourage the population to migrate from rural areas to urban areas.
(D) Promote the unlimited exploitation of the Earth's natural resources.

57. An example of mass transfer across an air-water interface is:
(A) The melting of glaciers.
(B) The formation of rocks from magma.
(C) The evaporation of water from a lake surface.
(D) The movement of tectonic plates.

58. Given below are two statements:
Statement I : The Environmental Lapse Rate (ELR) is the actual rate of temperature change with altitude at a given time and place.
Statement II : The Adiabatic Lapse Rate (ALR) is a fixed, universal constant that does not change under any circumstances.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Statement I is correct, but Statement II is incorrect.
(C) Statement I is incorrect, but Statement II is correct.
(D) Both Statement I and Statement II are incorrect.

59. The heat transfer mechanism responsible for a metal spoon becoming hot when left in a cup of hot tea is:
(A) Convection
(B) Radiation
(C) Evaporation
(D) Conduction

60. Which of the following is considered a natural resource?
(A) Plastic bags
(B) Sunlight
(C) Computer software
(D) Factory machinery

61. Remote sensing sensors that generate their own energy to illuminate the target are called:
(A) Passive sensors
(B) Optical sensors
(C) Active sensors
(D) Thermal sensors

62. A GIS database representing a city map where roads are lines, parks are polygons, and traffic lights are points is an example of:
(A) The raster data model
(B) A digital elevation model
(C) A satellite image
(D) The vector data model

63. The process of assessing natural resources involves:
(A) Determining the quantity, quality, and value of the resources.
(B) Only counting the total number of trees within a forest.
(C) Preventing any human use of the natural resources available.
(D) Using resources as quickly as possible for economic gain.

64. Which of the following best describes the interaction between Earth, Man, and Environment?
(A) It is a one-way interaction where the environment affects man, but not vice-versa.
(B) It is a dynamic relationship where humans modify and are affected by environment.
(C) It is a static, unchanging relationship that has remained constant over time.
(D) The interaction is limited specifically to the extraction of resources by humans.

65. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The biosphere is a self-contained system that does not depend on the other spheres of the Earth.
Reason (R) : The flow of energy from the sun and the cycling of nutrients involve the atmosphere, hydrosphere, and lithosphere.
(A) Both A and R are true and R is the correct explanation of A.

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(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

66. The part of the electromagnetic spectrum most commonly used for thermal remote sensing is:
(A) Infrared
(B) Ultraviolet
(C) Visible light
(D) Microwave

67. Which of these is a significant component of the hydrosphere?
(A) The ozone layer
(B) Tectonic plates
(C) Glaciers and ice caps
(D) The Earth's mantle

68. The basic equation for material balance is:
(A) Input + Output = Accumulation
(B) Input = Output - Accumulation
(C) Accumulation = Input / Output
(D) Input - Output = Accumulation

69. Consider the following statements about the application of remote sensing and GIS:
(a) They can be used to monitor the rate of urban sprawl.
(b) They help in identifying areas prone to desertification.
(c) They are useful for planning and management of forest resources.
(d) They can assess changes in glacial ice cover over time.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (c) and (d) only
(C) (a), (c), and (d) only
(D) (a), (b), (c), and (d)

70. The dew point temperature is the temperature at which:
(A) Water boils at standard atmospheric pressure.
(B) Air becomes saturated and condensation begins to form.
(C) The maximum amount of solar radiation is received.
(D) The wind speed is at its lowest recorded point.

71. Which component of Environmental Science deals with the moral implications of human actions on the natural world?
(A) Environmental Engineering
(B) Environmental Chemistry
(C) Environmental Economics
(D) Environmental Ethics

72. In a GIS, what does 'raster' data represent?
(A) A grid of cells, or pixels, with each cell containing a value.
(B) Features represented as points, lines, and polygons.
(C) A network of interconnected digital nodes and links.
(D) A sophisticated 3D digital model of the terrain.

73. The primary reason for the existence of different agro-climatic zones in India is the wide variation in:
(A) Population density
(B) Political systems
(C) Climatic and soil conditions
(D) Languages spoken

74. Everything is related to everything else, but near things are more related than distant things. This is a fundamental concept in geography that is operationalized by:
(A) GIS
(B) The Second Law of Thermodynamics
(C) The principle of uniformitarianism
(D) Environmental ethics

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75. Consider the following events/concepts:
(a) The Brundtland Commission report 'Our Common Future'
(b) The Stockholm Conference on the Human Environment
(c) The Rio Earth Summit
(d) The rise of industrial-era pollution
Which of the following is the correct chronological order of their prominence?
(A) (d), (b), (a), (c)
(B) (a), (b), (d), (c)
(C) (b), (a), (c), (d)
(D) (d), (a), (b), (c)

76. The concept of material balance is a direct application of the:

(A) Law of Conservation of Energy
(B) Law of Conservation of Mass
(C) Law of Increasing Entropy
(D) Law of Diminishing Returns

77. An environmental scientist studying the impact of a new dam on fish migration is working within the scope of:
(A) Atmospheric science only
(B) Geopolitics
(C) Environmental Science
(D) Theoretical physics

78. The layer of the atmosphere that contains the 'good' ozone which protects us from harmful UV radiation is the:
(A) Troposphere
(B) Mesosphere
(C) Thermosphere
(D) Stratosphere

79. Match List I with List II.
List I: (Process)
P. Warming of Earth's surface by the sun
Q. Circulation of water in a boiling pot
R. Heat moving along a solid iron rod
S. Land and sea breezes
List II: (Heat Transfer Mechanism)
1. Conduction
2. Convection
3. Radiation
4. Both Convection and Radiation
(A) P-3, Q-2, R-1, S-2
(B) P-2, Q-3, R-1, S-4
(C) P-3, Q-1, R-2, S-4
(D) P-1, Q-2, R-3, S-2

80. A stable atmosphere is characterized by:
(A) Strong vertical mixing of ambient air.
(B) The tendency of a lifted air parcel to return to its original position.
(C) The formation of very large cumulonimbus clouds.
(D) An environmental lapse rate much greater than the adiabatic lapse rate.

81. A wind rose with very long bars extending to the southwest indicates that:
(A) The strongest winds come from the northeast.
(B) The wind blows most frequently from the southwest.
(C) The wind rarely blows from the southwest.
(D) The temperature is highest when wind is from the southwest.

82. The term anthropogenic refers to something that is:
(A) Caused or influenced by human beings.
(B) Naturally occurring in the environment.
(C) Related to the study of animals.
(D) A feature of the Earth's geology.

83. Consider the following statements about sustainable development:
(a) It is solely focused on environmental conservation, ignoring economic aspects.
(b) It promotes the use of non-renewable resources without any planning.
(c) It seeks to balance environmental, social, and economic concerns.
(d) It recognizes the needs of both present and future generations.
(e) It was first defined in the Kyoto Protocol.
Which of the above statement(s) is/are correct?
(A) (a) and (e) only
(B) (c) and (d) only
(C) (b), (c), and (d)
(D) (a), (b), and (e)

84. The assessment of natural resources is crucial for:
(A) Rapid and complete exploitation of resources.
(B) Proving their existence without any human use.
(C) Creating entirely artificial natural resources.
(D) Sustainable management and planning.

85. Digital image classification, a part of Digital Image Processing, is the process of:
(A) Correcting the geometry of a satellite image.
(B) Enhancing the visual contrast of a digital image.
(C) Categorizing pixels in an image into land cover classes.
(D) Storing the image in a highly compressed format.

86. Given below are two statements:
Statement I : Passive remote sensing systems are dependent on the sun's energy as a source of

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illumination.

Statement II : Active remote sensing systems, like Radar, can acquire data at night or through cloud cover.

Which of the following is correct?

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct, but Statement II is incorrect.
(D) Statement I is incorrect, but Statement II is correct.

87. Which of the following is an example of non-formal environmental education?

(A) A university degree course in Environmental Science.
(B) A chapter on ecology in a school textbook.
(C) A PhD research program on climate change.
(D) A television documentary about wildlife conservation.

88. The ecocentric worldview would most likely support which of the following actions?

(A) Preserving a wilderness area in its natural state, even if it means forgoing economic benefits.
(B) Building a dam to create a reservoir for human recreation.
(C) Clearing a forest to create agricultural land for a growing population.
(D) Introducing a non-native species to control a native pest.

89. A material balance study is conducted on a lake. The inputs are 100 units/day of water, and the outputs are 80 units/day. What is the accumulation in the lake per day?

(A) 180 units/day
(B) -20 units/day
(C) 20 units/day
(D) 1.25 units/day

90. The concept that the processes that have shaped the Earth in the geological past are essentially the same as those operating today is a fundamental principle of geology, but the interdisciplinary nature of Environmental Science means understanding:

(A) That human activities are now a major force of change.
(B) That past processes have no relevance to the present.
(C) Only the biological components of the environment.
(D) That the Earth system is fundamentally static.

91. Which of the following correctly pairs a component of the atmosphere with its approximate percentage by volume?

(A) Oxygen - 78%
(B) Nitrogen - 21%
(C) Carbon Dioxide - 1%
(D) Argon - 0.93%

92. The majority of Earth's fresh water is found in:

(A) Rivers and lakes
(B) Glaciers and ice sheets
(C) Groundwater
(D) The atmosphere

93. The Earth's crust and the uppermost part of the mantle together constitute the:

(A) Asthenosphere
(B) Core
(C) Lithosphere
(D) Hydrosphere

94. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : In a temperature inversion layer, air pollution levels can increase dramatically.

Reason (R) : The warm inversion layer acts as a lid, preventing the upward dispersal of pollutants from the cooler air below.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

95. In remote sensing, what is a 'pixel'?

(A) The smallest single element of a digital image.
(B) The satellite that captures a digital image.
(C) The entire range of the electromagnetic spectrum.
(D) A type of sensor used for night-time imaging.

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96. Ground truthing is essential for improving the accuracy of:
(A) Climate models.
(B) The classification of remotely sensed data.
(C) Thermodynamic calculations.
(D) Ethical arguments.

97. An application of GIS in forestry could involve:
(A) Creating a new species of tree through genetic engineering.
(B) Mapping forest fire risk zones based on fuel type, slope, and weather data.
(C) Automatically cutting down trees using a robotic system.
(D) Calculating the age of a single tree by analyzing its rings.

98. Which of the following is the most appropriate example of a competency-based objective in environmental education?
(A) Students will be able to analyze a local environmental issue and propose a viable solution.
(B) Students will be able to list the layers of the atmosphere.
(C) Students will know the definition of sustainable development.
(D) Students will be able to recall the formula for ozone.

99. The tragedy of the commons is a concept often discussed in environmental ethics and resource management. It describes a situation where:
(A) A single individual conserves a resource for the good of all.
(B) A community successfully manages a shared resource for long-term sustainability.
(C) Shared resources are inevitably overexploited and degraded by individuals acting in their own self-interest.
(D) A resource is privately owned and therefore perfectly managed.

100. Match List I with List II.
List I: (Term)
P. Wind Rose
Q. Vector Data
R. Second Law
S. Biocentrism
List II: (Associated Field/Concept)
1. GIS
2. Thermodynamics
3. Environmental Ethics
4. Meteorology
(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-2, R-1, S-3
(D) P-3, Q-1, R-4, S-2

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101. Consider the following biogeographic realms:
(a) Palearctic
(b) Nearctic
(c) Neotropical
(d) Afrotropical
Which of the following is the correct order by their approximate land area, from largest to smallest?
(A) (a), (d), (b), (c)
(B) (a), (b), (c), (d)
(C) (d), (c), (a), (b)
(D) (c), (b), (d), (a)

102. The concept of Environmental Ethics primarily addresses the question:
(A) How much does it cost to clean up pollution?
(B) What is the moral relationship between humans and the non-human world?
(C) What are the chemical properties of pollutants?
(D) How can we use technology to control the environment?

103. The fundamental principle of remote sensing is based on the interaction of _____ with objects on the Earth's surface.
(A) Sound waves
(B) Gravitational forces
(C) Magnetic fields
(D) Electromagnetic radiation

104. Consider the following statements related to the principles and scope of environmental science:
(a) It is a monodisciplinary science, focused only on biology.
(b) Its scope includes the study of climate change, biodiversity loss, and pollution.
(c) It often deals with complex systems with many interacting components.
(d) The principle of sustainability is a central theme.
Which of the above statement(s) is/are correct?
(A) (a), (b), and (c)

(B) (b), (c), and (d)
(C) (a) and (d) only
(D) (a), (c), and (d)

105. What is the primary difference between the Environmental Lapse Rate (ELR) and the Adiabatic Lapse Rate (ALR)?
(A) ELR applies to rising air, while ALR applies to sinking air.
(B) ELR is measured in Celsius per km, while ALR is measured in Fahrenheit per mile.
(C) ELR is the actual temperature profile of the ambient air, while ALR is the rate of temperature change in a moving air parcel.
(D) ELR is constant, while ALR varies with location and time.

106. A GIS is used to overlay a map of soil types, a map of slope, and a map of rainfall to produce a new map showing areas at high risk of erosion. This process is an example of:
(A) Spatial analysis
(B) Data acquisition
(C) Ground truthing
(D) Image classification

107. Given below are two statements:
Statement I : According to the First Law of Thermodynamics, energy flowing through an ecosystem is eventually destroyed.
Statement II : The Second Law of Thermodynamics suggests that with each energy transfer in an ecosystem, some energy is lost as heat, leading to less available energy at higher trophic levels.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Statement I is incorrect, but Statement II is correct.
(C) Statement I is correct, but Statement II is incorrect.
(D) Both Statement I and Statement II are incorrect.

108. The main difference between 'weather' and 'climate' is the:
(A) Type of parameters measured.
(B) Time scale of the phenomena.
(C) Geographic area covered.
(D) Altitude at which they occur.

109. Which of the following is NOT a meteorological parameter?
(A) Humidity
(B) Wind velocity
(C) Soil pH
(D) Air pressure

110. The concept that the Earth's lithosphere is divided into a number of plates that move and interact with each other is fundamental to understanding the:
(A) Hydrological cycle
(B) Structure of the lithosphere
(C) Composition of the atmosphere
(D) Principles of thermodynamics

111. Consider the following statements about Remote Sensing and GIS applications:
(a) GIS is used to plan optimal routes for emergency vehicles.
(b) Remote sensing can help in the assessment of crop health over large areas.
(c) GIS and remote sensing are ineffective for studying climate change impacts.
(d) LULC (Land Use/Land Cover) mapping is a major application of remote sensing.
(e) Ground truthing makes the results of remote sensing analysis less reliable.
Which of the above statement(s) is/are correct?
(A) (a), (b) and (d)
(B) (c), (d) and (e)
(C) (a), (c) and (e)
(D) (b), (c) and (d)

112. The most appropriate term for the portion of the Earth that is frozen, including glaciers, ice caps, and permafrost, is the:
(A) Hydrosphere
(B) Cryosphere
(C) Lithosphere
(D) Biosphere

113. An air parcel is forced to rise. It cools adiabatically and its temperature drops below the surrounding air temperature. The parcel will then tend to sink back to its original level. This indicates that the atmosphere is:
(A) Unstable
(B) Stable
(C) Neutral
(D) Saturated

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114. The Brundtland Report, Our Common Future, is most famous for its definition of:
(A) Sustainable Development
(B) Environmental Impact Assessment
(C) The Precautionary Principle
(D) The Polluter Pays Principle

115. An example of a renewable natural resource is:
(A) Coal
(B) Petroleum
(C) Solar energy
(D) Natural gas

116. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : A key principle of environmental science is that everything must go somewhere.
Reason (R) : This principle is a restatement of the Law of Conservation of Mass, which underlies the concept of material balance.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

117. Given below is a case study of a city experiencing increased flash floods after rapid urbanization. A GIS and remote sensing analysis reveals a significant increase in impervious surfaces over the last $_2$0 years. This increase in impervious surfaces is the primary cause because it:
(A) Dramatically increases the rate of groundwater recharge within the city.
(B) Significantly decreases the speed of water flow across the urban landscape.
(C) Reduces rainwater infiltration into soil, increasing surface runoff volumes.
(D) Cools the city environment, leading to more frequent and intense rainfall.

118. Which of the following is an INCORRECT statement about the biosphere?
(A) It encompasses parts of the lithosphere, hydrosphere, and atmosphere.
(B) It functions independently of solar energy.
(C) It is the global sum of all ecosystems.
(D) It exists as a thin layer on the Earth's surface.

119. The transfer of energy between two objects in direct physical contact is:
(A) Convection
(B) Radiation
(C) Adsorption
(D) Conduction

120. Which of the following is the most significant anthropogenic source of change in the Earth's environment?
(A) Burning of fossil fuels
(B) Volcanic eruptions
(C) Solar flares
(D) Tectonic plate movement

121. The Planning Commission of India has divided the country into how many major agro-climatic zones?
(A) 10
(B) 20
(C) 15
(D) 25

122. In remote sensing, the specific range of wavelengths that a sensor is designed to detect is known as its:
(A) Spectral band
(B) Spatial resolution
(C) Temporal resolution
(D) Radiometric resolution

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123. The ethical theory that places value only on humans and human interests is:
(A) Ecocentrism
(B) Biocentrism
(C) Holism
(D) Anthropocentrism

124. Match List I with List II.
List I: (Atmospheric Layer)
P. Troposphere
Q. Stratosphere
R. Mesosphere
S. Thermosphere
List II: (Key Feature)
1. Meteors burn up
2. Contains Ozone Layer
3. Weather phenomena occur
4. Aurora Borealis, high temperatures
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-1, S-4

(C) P-3, Q-1, R-2, S-4
(D) P-1, Q-2, R-3, S-4

125. The main purpose of environmental awareness campaigns is to:
(A) Punish people who pollute the local environment.
(B) Generate profits for various environmental organizations.
(C) Inform the public and influence their behaviors toward the environment.
(D) Conduct detailed scientific research on industrial pollution.

126. A student is analyzing a satellite image to identify different types of vegetation in a national park. The student then visits the park to verify that the areas identified as 'pine forest' on the map are indeed pine forests. This verification process is called:
(A) Image enhancement
(B) Geometric correction
(C) Radiometric calibration
(D) Ground truthing

127. If an air parcel is warmer and less dense than the surrounding air, it will tend to rise. This condition promotes vertical air movement and is characteristic of an _____ atmosphere.
(A) Unstable
(B) Stable
(C) Inverted
(D) Neutral

128. Consider the following statements regarding the composition of the atmosphere:
(a) Nitrogen is the most abundant gas.
(b) The concentration of water vapor is constant throughout the atmosphere.
(c) Ozone is concentrated in the troposphere.
(d) Argon is more abundant than carbon dioxide.
Which of the above statement(s) is/are correct?
(A) (a) and (d) only
(B) (a), (b), and (c)
(C) (b) and (c) only
(D) (a), (c), and (d)

129. The concept of material balance is used in environmental science to:
(A) Measure wind velocity.
(B) Track the flow of materials and energy through a system.
(C) Argue for specific ethical viewpoints.
(D) Define biogeographic provinces.

130. The three pillars of sustainable development refer to the integration of which three aspects?
(A) Economic, Social, and Environmental
(B) Past, Present, and Future
(C) Local, National, and Global
(D) Air, Water, and Soil

131. A biome is a large community of vegetation and wildlife adapted to a specific climate. Biomes are the largest geographic biotic unit, and the concept is closely related to:
(A) The layers of the atmosphere.
(B) The laws of thermodynamics.
(C) Biogeographic provinces.
(D) Remote sensing principles.

132. Which of the following is an example of a cause-and-effect relationship in environmental science?
(A) The presence of nitrogen and oxygen in the atmosphere.
(B) The classification of resources as renewable or non-renewable.
(C) The definition of environmental ethics.
(D) Increased greenhouse gas emissions leading to global warming.

133. The dry adiabatic lapse rate (DALR) is approximately:
(A) 6.5°C per km
(B) 4°C per km
(C) 10°C per km
(D) 0°C per km

134. Given below are two statements:
Statement I : GIS is primarily a tool for creating visually pleasing maps and has limited analytical capabilities.
Statement II : A key strength of GIS is its ability to perform spatial analysis by integrating and analyzing data from various sources based on geographic location.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are

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incorrect.
(C) Statement I is correct, but Statement II is incorrect.
(D) Statement I is incorrect, but Statement II is correct.

135. The environmental ethic that accords moral consideration to all living things is:
(A) Anthropocentrism
(B) Holism
(C) Individualism
(D) Biocentrism

136. Consider the following forms of water in the hydrosphere:
(a) Groundwater
(b) Oceans
(c) Glaciers and Ice Caps
(d) Lakes and Rivers
Which of the following is the correct order based on their volume, from largest to smallest?
(A) (b), (c), (a), (d)
(B) (c), (b), (a), (d)
(C) (b), (a), (c), (d)
(D) (a), (c), (b), (d)

137. Which of the following is NOT a primary goal of environmental education?
(A) To foster awareness and concern about environmental issues.
(B) To develop skills for identifying and solving environmental problems.
(C) To promote a single, prescribed political ideology.
(D) To encourage active participation in environmental improvement.

138. The interaction of man and environment is a central theme in Environmental Science. Which of the following represents a modern, significant interaction?
(A) The anthropogenic contribution to climate change.
(B) The construction of pyramids in ancient Egypt.
(C) The natural process of mountain formation.
(D) The migration patterns of early hominids.

139. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : GIS is a powerful tool for land use planning and management.
Reason (R) : GIS allows for the integration and analysis of diverse spatial datasets such as zoning regulations, soil types, slope, and existing infrastructure, which aids in decision-making.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

140. A scientist uses satellite images taken in 1990 and 2020 to map the expansion of a city into surrounding agricultural land. This study is an analysis of:
(A) Urban heat island effect
(B) Urban sprawling
(C) Urban water quality
(D) Urban air pollution patterns

141. The principle of remote sensing involves which sequence of events?
(A) Sensor -> Target -> Source of Energy
(B) Target -> Sensor -> Source of Energy
(C) Source of Energy -> Target -> Sensor
(D) Sensor -> Source of Energy -> Target

142. Consider the following statements regarding the Laws of Thermodynamics:
(a) The First Law is concerned with the quantity of energy.
(b) The Second Law is concerned with the quality of energy.
(c) The First Law states that energy cannot be created or destroyed.
(d) The Second Law implies that perpetual motion machines of the first kind are impossible.
(e) The Second Law states that the entropy of an isolated system tends to increase.
Which of the above statement(s) is/are correct?
(A) (a), (b), (c) and (e) only
(B) (b), (c), (d) and (e) only
(C) (a), (c) and (d) only
(D) (a), (b), (d) and (e) only

143. Which of the following is an example of an abiotic component of an ecosystem?
(A) Sunlight

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(B) A tree
(C) A fungus
(D) A bacterium

144. The fundamental difference between a resource and a reserve is that a reserve is a resource that is:
(A) Non-renewable in nature.
(B) Economically and technologically feasible to extract.
(C) Currently undiscovered by surveys.
(D) Located in another distant country.

145. An instrument that measures atmospheric pressure is called a:
(A) Thermometer
(B) Barometer
(C) Anemometer
(D) Hygrometer

146. Which of the following is the most comprehensive and holistic ethical framework?
(A) Ecocentrism
(B) Anthropocentrism
(C) Biocentrism
(D) Speciesism

147. A wind rose provides information about:
(A) The chemical composition of the wind.
(B) The age and origin of the local wind.
(C) The frequency of wind directions and speeds.
(D) The temperature and humidity of the wind.

148. Match List I with List II.
List I: (GIS/RS Term)
P. Vector Data
Q. Raster Data
R. Ground Truthing
S. Digital Image Processing
List II: (Definition)
1. Field verification of remotely sensed data
2. Representation of data as a grid of pixels
3. Manipulation and enhancement of satellite images
4. Representation of data as points, lines, and polygons
(A) P-4, Q-2, R-1, S-3
(B) P-2, Q-4, R-1, S-3
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-2, R-3, S-4

149. The interdisciplinary nature of Environmental Science means it incorporates knowledge from which fields?
(A) Only biology and chemistry.
(B) Only physics and geology.
(C) Natural sciences, social sciences, and humanities.
(D) Only engineering and technology.

150. A situation where a rising parcel of air has the same temperature as its surroundings at all altitudes indicates a _____ atmosphere.
(A) Stable
(B) Neutral
(C) Unstable
(D) Inverted

151. Which of the following best describes the scope of environmental science?
(A) A narrow field focused only on endangered species.
(B) A sub-discipline of chemistry dealing with pollutants.
(C) The study of extraterrestrial environments.
(D) A field covering all environment and human interactions.

152. In the material balance equation (Input - Output = Accumulation), if the accumulation term is negative, it means:
(A) The amount of substance in the system is decreasing.
(B) The system is in steady state.
(C) The amount of substance in the system is increasing.
(D) The inputs are equal to the outputs.

153. Consider the following statements about the atmosphere:
(a) The troposphere is the densest layer.
(b) The stratosphere is where commercial jets prefer to fly to avoid weather turbulence.
(c) The thermosphere is the coldest layer of the atmosphere.
(d) The composition of the atmosphere is uniform at all altitudes.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (c) and (d) only
(C) (a), (b), and (c)
(D) (b), (c), and (d)

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154. The process of heat transfer that causes the formation of land and sea breezes is:
(A) Convection
(B) Conduction
(C) Radiation
(D) Adsorption

155. Which of the following is a key feature of the lithosphere?
(A) It is in a constant state of liquid flux.
(B) It is composed primarily of water.
(C) It is the primary location of weather phenomena.
(D) It is divided into tectonic plates.

156. An environmental ethicist argues that old-growth forests should be preserved because they are complex ecosystems that have intrinsic value, apart from any use to humans. This argument is an example of:
(A) Anthropocentrism
(B) Ecocentrism
(C) Technocentrism
(D) Cornucopianism

157. Given below are two statements:
Statement I : Sustainable development requires meeting the needs of the present generation.
Statement II : Sustainable development also requires not compromising the ability of future generations to meet their own needs.
Which of the following is correct?
(A) Both Statement I and Statement II are true, and Statement II is a necessary condition for Statement I.
(B) Both statements are true and form the definition of sustainable development.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

158. The classification of India into agro-climatic zones is primarily for the purpose of:
(A) Promoting tourism.
(B) Delineating political constituencies.
(C) Managing industrial pollution.
(D) Enhancing agricultural planning and productivity.

159. What is the role of ground truthing in a remote sensing project?
(A) To provide reference data for verifying the accuracy of image analysis.
(B) To launch the satellite.
(C) To calibrate the sensor before flight.
(D) To process the data at the ground station.

160. Given below is a case study of a coastal town facing severe beach erosion. A GIS analysis is performed by overlaying historical shoreline data, wave energy maps, and locations of coastal structures. The analysis reveals that a new jetty has altered longshore drift. This exemplifies the use of GIS for:
(A) Designing a new satellite sensor.
(B) Identifying the cause of an environmental problem.
(C) Measuring atmospheric pressure.
(D) Promoting an anthropocentric ethic.

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161. Which of the following is a non-renewable natural resource?
(A) Wind
(B) Coal
(C) Timber from a managed forest
(D) Tidal energy

162. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Second Law of Thermodynamics dictates that energy transfers are never 100% efficient.
Reason (R) : In any energy transfer, some energy is inevitably converted into a less useful form, typically low-quality heat, increasing the entropy of the universe.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

163. The primary foothold of the ozone layer in the stratosphere is to:
(A) Trap heat, keeping the Earth warm.
(B) Cause weather phenomena like rain and snow.
(C) Absorb harmful ultraviolet radiation from the sun.
(D) Provide the oxygen that we breathe.

164. In GIS, a 'layer' or 'theme' typically represents:
(A) The entire map of the world.
(B) A specific software command.
(C) The physical thickness of a printed map.
(D) A single type of geographic feature, such as roads or rivers.

165. The term 'mixing ratio' in meteorology refers to the mass of water vapor in a unit mass of:
(A) Wet air
(B) Liquid water
(C) Dry air
(D) Ice

166. Match List I with List II.
List I: (Parameter)
P. Temperature
Q. Humidity
R. Wind speed
S. Pressure
List II: (Instrument)
1. Anemometer
2. Barometer
3. Hygrometer
4. Thermometer
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-4, S-1

167. Which of the following is the best example of a positive feedback loop in the environment?
(A) Increased plant growth absorbing more CO2, leading to cooling.
(B) A thermostat in a house turning off the heat at a set temperature.
(C) Increased predator population leading to a decrease in local prey.
(D) Melting Arctic sea ice reducing albedo and causing further melting.

168. The study of the interaction between living organisms and their environment is a core component of:
(A) Environmental Science
(B) Geopolitics
(C) Astrophysics
(D) Organic Chemistry

169. What does the term digital image processing refer to in the context of remote sensing?
(A) The physical printing of satellite photos.
(B) The conversion of analog photos to digital format.
(C) The use of computer algorithms to analyze and manipulate digital imagery.
(D) The design of the camera lens on a satellite.

170. Consider the following statements:
(a) Environmental systems are in a state of dynamic equilibrium.
(b) Environmental problems do not cross political boundaries.
(c) The Earth can be considered a closed system with respect to materials.
(d) All environmental solutions must be purely technological.
(e) Human culture is a part of the environment.
Which of the above statement(s) is/are correct?
(A) (a), (b), and (d) only
(B) (a), (c), and (e) only
(C) (b), (c), and (d) only
(D) (a), (d), and (e) only

171. The biosphere is best described as:
(A) The part of the Earth's crust composed of rocks.
(B) The layer of gases surrounding the Earth.
(C) The total amount of water on Earth.
(D) The sum of all regions on Earth where life exists.

172. The ultimate source of energy for almost all life in the biosphere is:
(A) Geothermal heat
(B) Solar radiation
(C) Tidal forces
(D) Chemical bonds in rocks

173. The concept of biogeographic provinces is used to classify regions based on their:
(A) Economic development
(B) Average annual temperature
(C) Shared evolutionary history of their plants and animals
(D) Predominant language

174. Consider the following units:
(a) Ecosystem
(b) Organism
(c) Biosphere
(d) Population

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Which of the following is the correct order of increasing complexity and scale?
(A) (b), (d), (a), (c)
(B) (d), (b), (a), (c)
(C) (b), (a), (d), (c)
(D) (a), (b), (c), (d)

175. The fundamental concept behind a GIS is the:
(A) Layering of different types of spatial information for the same geographic area.
(B) Measurement of electromagnetic radiation.
(C) Study of ethical principles.
(D) Law of conservation of energy.

176. Which one of the following is not a characteristic of Environmental Science?
(A) It is interdisciplinary.
(B) It is a static and unchanging field of study.
(C) It is a holistic science.
(D) It includes social, ethical, and political aspects.

177. The process by which water vapor in the air is changed into liquid water is called:
(A) Evaporation
(B) Condensation
(C) Precipitation
(D) Transpiration

178. The statement The present is the key to the past is a summary of the principle that underlies the study of the lithosphere. This principle, when applied to environmental science, helps us understand:
(A) That geological processes operate on very long timescales.
(B) That only recent events are important.
(C) That the lithosphere is not important for life.
(D) That all rocks are the same age.

179. A city's planners want to identify the best locations for new parks. They use a GIS to analyze data on population density, current park locations, and land availability. This is an application of GIS in:
(A) Waste management
(B) Climate change monitoring
(C) Land use planning
(D) Forestry

180. The First Law of Thermodynamics, when applied to an ecosystem, states that:
(A) Entropy always increases.
(B) Energy is degraded with each transfer.
(C) Only a fraction of energy is transferred between trophic levels.
(D) The energy flowing into the system must equal the energy flowing out plus any change in stored energy.

181. What type of atmospheric condition is most conducive to the dispersal of air pollutants?
(A) A strong temperature inversion.
(B) A stable atmosphere.
(C) An unstable atmosphere with significant vertical mixing.
(D) Calm, windless conditions.

182. A map showing the 15 agro-climatic zones of India is a tool for:
(A) International diplomacy.
(B) Regional agricultural planning and resource management.
(C) Urban infrastructure development.
(D) Demarcating state boundaries.

183. Consider the following statements about Remote Sensing:
(a) It is the science of obtaining information about objects without being in direct contact.
(b) Passive sensors use their own energy source.
(c) Active sensors can operate during both day and night.
(d) Aerial photographs are a form of remote sensing.
Which of the above statement(s) is/are correct?
(A) (a), (c), and (d)
(B) (a), (b), and (c)
(C) (b) and (d) only
(D) (a) and (c) only

184. The most fundamental aspect of environmental ethics is asking:
(A) What moral obligations do we have regarding the environment?
(B) How can we profit most from the environment?
(C) What are the chemical formulas of pollutants?
(D) Which technologies are most efficient?

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185. In a GIS, attribute data for a 'roads' layer might include which of the following?
(A) The shape and location of the roads.
(B) A satellite image of the area.
(C) The name, length, and surface type of the roads.
(D) The elevation of the surrounding terrain.

186. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Environmental education is only for children in schools.
Reason (R) : Environmental awareness and action are needed across all sectors and age groups of society, including through formal and non-formal education.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

187. The layer of the atmosphere where temperature decreases with altitude at an average rate of 6.5°C/km is the:
(A) Stratosphere
(B) Mesosphere
(C) Thermosphere
(D) Troposphere

188. Which of the following best represents the concept of sustainable development?
(A) Maximizing resource extraction for immediate economic gain.
(B) Balancing economic, social, and environmental goals for well-being.
(C) Preserving the environment by halting all development.
(D) Focusing solely on social equity at the expense of other concerns.

189. Which heat transfer process does not require a medium?
(A) Conduction
(B) Convection
(C) Radiation
(D) Both A and B

190. Match List I with List II.
List I: (Environmental Ethic)
P. Anthropocentrism
Q. Biocentrism
R. Ecocentrism
S. Technocentrism
List II: (Core Belief)
1. All living beings have intrinsic value.
2. Human interests and values are paramount.
3. Technology can solve all environmental problems.
4. The whole ecosystem, including abiotic parts, has moral standing.
(A) P-1, Q-2, R-4, S-3
(B) P-2, Q-1, R-3, S-4
(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-4, R-1, S-2

191. When applying a mass balance to a system at steady state, the accumulation term is:
(A) Equal to zero
(B) Equal to one
(C) Greater than the input
(D) Less than the output

192. A GIS would be most useful for answering which of the following questions?
(A) What is the chemical composition of a water sample?
(B) Which areas are vulnerable to pollution based on land use and slope?
(C) What is the moral justification for preserving a species?
(D) What is the history of the environmental movement?

193. The gradual increase in the concentration of a pollutant at successively higher levels in a food chain is an example of a process that Environmental Science studies. This demonstrates that the discipline is:
(A) Irrelevant to human health.
(B) Concerned with interconnected systems.
(C) Focused only on physical phenomena.
(D) Limited to the study of single organisms.

194. The term 'lapse rate' refers to the rate of change of which parameter with altitude?
(A) Temperature
(B) Pressure
(C) Humidity
(D) Wind speed

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195. The primary components of the lithosphere are:
(A) Gases and water vapor
(B) Living organisms
(C) Rocks and minerals
(D) Ice and snow

196. The study of how to create and manage sustainable human settlements and communities is an aspect of:
(A) The laws of thermodynamics
(B) The structure of the mesosphere
(C) Passive remote sensing
(D) The scope of Environmental Science

197. Which one of the following correctly describes the interaction between the spheres of the Earth?
(A) The biosphere is isolated from the lithosphere.
(B) The atmosphere does not exchange energy with the hydrosphere.
(C) The hydrosphere and atmosphere interact during the water cycle.
(D) The lithosphere is a completely closed system.

198. An energy specialist analyzing the efficiency of a power plant would be most concerned with which law?
(A) The Law of Gravity
(B) The Second Law of Thermodynamics
(C) The Law of Conservation of Mass
(D) The Law of Averages

199. A wind rose showing equally long spokes in all directions would indicate:
(A) Very strong winds from one direction.
(B) Calm conditions.
(C) Consistently high temperatures.
(D) Variable wind directions with no dominant direction.

200. Consider the following statements about sustainable development:
(a) It is based on the premise that natural resources are finite.
(b) It involves a trade-off between the present and the future.
(c) It has social, economic, and environmental dimensions.
(d) It was officially adopted as a guiding principle at the Rio Earth Summit in 1992.
(e) It is primarily an economic theory with little environmental input.
Which of the above statement(s) is/are correct?
(A) (a), (c), and (d) only
(B) (b), (c), and (e) only
(C) (a), (b), (c), and (d)
(D) (c), (d), and (e) only

201. Which of the following resources is considered renewable?
(A) Natural Gas
(B) Uranium
(C) Geothermal energy
(D) Crude Oil

202. Which of the following questions falls under the purview of environmental ethics?
(A) Do other species have a right to exist, independent of their usefulness to humans?
(B) How does a catalytic converter reduce emissions?
(C) What is the concentration of lead in this soil sample?
(D) How can we use GIS to map deforestation?

203. Given below are two statements:
Statement I : The lithosphere is a static and unchanging part of the Earth.
Statement II : The theory of plate tectonics describes the motion and interaction of lithospheric plates, leading to earthquakes, volcanoes, and mountain building.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct, but Statement II is incorrect.
(D) Statement I is incorrect, but Statement II is correct.

204. The primary goal of a material balance analysis in an environmental context is to:
(A) Determine the economic value of a resource.
(B) Account for the flow and fate of a substance in a defined system.
(C) Establish ethical guidelines for resource use.
(D) Measure the atmospheric pressure.

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205. The part of a satellite sensor system that provides the energy to illuminate a target is a feature of:
(A) A passive system
(B) A GPS receiver
(C) An active system
(D) Ground truthing equipment

206. Consider the following sequence of events:
(a) Absorption of heat by land and water
(b) Solar radiation reaches Earth's atmosphere
(c) Convection currents create wind
(d) Reradiation of infrared energy from the surface
Which of the following is the correct order of energy transfer in the environment?
(A) (b), (a), (d), (c)
(B) (a), (b), (c), (d)
(C) (b), (d), (a), (c)
(D) (d), (c), (a), (b)

207. Which of the following is a major biogeographic province (realm)?
(A) The Nearctic Realm
(B) The Amazon Rainforest
(C) The Sahara Desert
(D) The Indian Subcontinent

208. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : An unstable atmosphere is associated with good visibility and the formation of convective clouds.
Reason (R) : In an unstable atmosphere, a lifted air parcel remains warmer than the surrounding air, causing it to continue rising, which promotes vertical mixing and cloud development.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

209. The application of remote sensing for vegetation study might involve:
(A) Taking soil samples to test for nutrient levels.
(B) Analyzing the Normalized Difference Vegetation Index (NDVI) from satellite imagery to assess plant health.
(C) Counting the rings on a felled tree.
(D) Interviewing local farmers about their crops.

210. Which statement best reflects an ecocentric perspective?
(A) The rainforest is an interconnected system with a right to exist for its own sake.
(B) We should protect the rainforest because it contains plants that might be sources of new medicines for humans.
(C) We can clear the rainforest if technology allows us to synthesize its products elsewhere.
(D) The rainforest should be managed by the people who live there for their own economic benefit.

211. The boundary between the troposphere and the stratosphere is known as the:
(A) Stratopause
(B) Mesopause
(C) Tropopause
(D) Thermopause

212. Match List I with List II.
List I: (Process/Concept)
P. Photosynthesis
Q. Hydrological Cycle
R. Plate Tectonics
S. Ozone formation
List II: (Relevant Sphere)
1. Atmosphere
2. Lithosphere
3. Hydrosphere
4. Biosphere
(A) P-4, Q-3, R-2, S-1
(B) P-1, Q-3, R-2, S-4
(C) P-4, Q-2, R-3, S-1
(D) P-3, Q-4, R-1, S-2

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213. The relative humidity of an air parcel increases when:
(A) The temperature increases, while the amount of water vapor remains constant.
(B) The pressure increases significantly.
(C) The temperature decreases, while the amount of water vapor remains constant.
(D) The amount of water vapor decreases, while temperature remains constant.

214. The carrying capacity concept, often discussed in environmental science, refers to:
(A) The maximum weight a vehicle can legally carry.
(B) The maximum population size of a species that the environment can sustain indefinitely.
(C) The amount of energy transferred between trophic levels.
(D) The total mass of the biosphere.

215. Consider the following statements about GIS:
(a) A GIS can only handle one type of data at a time.
(b) Vector data is generally better for representing continuous surfaces like elevation.
(c) Raster data uses a grid of cells to represent spatial information.
(d) The primary function of GIS is to link spatial data with attribute data.
Which of the above statement(s) is/are correct?
(A) (a) and (b)
(B) (b) and (d)
(C) (c) and (d)
(D) (a) and (c)

216. The Brundtland Commission's definition of sustainable development is an example of a principle that falls within the scope of:
(A) Environmental Science
(B) Only Economics
(C) Only Sociology
(D) Only Political Science

217. The heat you feel from a campfire a few feet away is transferred to you primarily by:
(A) Conduction
(B) Convection
(C) Radiation
(D) Advection

218. An example of applying the principle of material balance at a global scale is the study of:
(A) The global carbon cycle.
(B) The ethics of animal rights.
(C) The design of a single solar panel.
(D) The zoning laws of a single city.

219. Formal environmental education would most likely take place in:
(A) A museum exhibit.
(B) A national park's nature trail.
(C) A television show.
(D) A university classroom.

220. Which concept is NOT part of the principles of remote sensing?
(A) Electromagnetic radiation
(B) Moral and ethical considerations
(C) Platforms and sensors
(D) Interaction with the target

221. The main difference between the dry adiabatic lapse rate (DALR) and the saturated adiabatic lapse rate (SALR) is that:
(A) The SALR is always greater than the DALR.
(B) The DALR applies only at night, while the SALR applies during the day.
(C) The SALR is less than the DALR because of the release of latent heat during condensation.
(D) The DALR is for sinking air, and the SALR is for rising air.

222. An assessment of natural resources for a region would typically include:
(A) A list of local political leaders.
(B) A census of the human population only.
(C) A history of the region's art and culture.
(D) An inventory of minerals, water, forests, and soil.

223. Given below are two statements:
Statement I : The biosphere is the part of the Earth where life exists.
Statement II : The biosphere is composed of numerous ecosystems which are communities of living organisms interacting with their physical environment.
Which of the following is correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

224. Which of the following is a direct application of GIS for climate change studies?
(A) Writing policy documents for international treaties.
(B) Modeling the potential impact of sea-level rise on coastal communities.

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(C) Developing new, more efficient solar panels.
(D) Arguing the ethics of climate change.

225. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Environmental problems are often complex and have multiple causes.
Reason (R) : Environmental science is an interdisciplinary field because it needs to integrate knowledge from various sciences like biology, chemistry, sociology, and economics to understand and solve these complex problems.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

226. The transfer of mass and energy across the air-sea interface is a crucial driver for:
(A) Global weather and climate patterns.
(B) Tectonic plate movement.
(C) The formation of rocks.
(D) The Earth's magnetic field.

227. The concept that all forms of life have an inherent right to exist is a cornerstone of:
(A) Anthropocentrism
(B) Technocentrism
(C) Biocentrism
(D) Resource management

228. Which layer of the atmosphere has the lowest average temperature?
(A) Troposphere
(B) Stratosphere
(C) Thermosphere
(D) Mesosphere

229. Consider the following statements about the principles of remote sensing:
(a) The process begins with an energy source.
(b) The energy interacts with the Earth's surface (the target).
(c) A sensor records the energy reflected or emitted from the target.
(d) The recorded data can be processed to extract useful information.
(e) It requires the analyst to be physically present at the target location.
Which of the above statement(s) is/are correct?
(A) (a), (b), and (c), and (d) only
(B) (b), (c), and (d), and (e) only
(C) (a), (c), and (e) only
(D) All of the above

230. A city government uses GIS to determine the most efficient routes for its garbage collection trucks, taking into account street layouts, traffic patterns, and bin locations. This is an application of GIS in:
(A) Forestry
(B) Waste management
(C) Vegetation study
(D) Urban sprawling analysis

231. The greenhouse effect, which keeps the Earth's surface warmer than it would be otherwise, is primarily due to:
(A) The absorption of ultraviolet radiation by ozone.
(B) The reflection of sunlight by clouds.
(C) The transfer of heat by conduction from the Earth's core.
(D) The absorption and re-emission of infrared radiation by gases.

232. Match List I with List II.
List I: (Term)
P. Material Balance
Q. Adiabatic Cooling
R. Ground Truthing
S. Anthropocentrism
List II: (Example/Definition)
1. Field visit to verify a classified map
2. Human-centered view
3. Input - Output = Accumulation
4. Cooling of a rising air parcel
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-4, S-1

233. Which of the following is the most accurate statement regarding the relationship between man and environment?
(A) Humans have always lived in perfect harmony with the environment.
(B) The environment is a passive backdrop for human activity.

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(C) Human activities have become a dominant force shaping environmental systems.
(D) The environment exclusively determines the course of human societies.

234. The scientific study of weather and the atmosphere is known as:
(A) Meteorology
(B) Geology
(C) Hydrology
(D) Ecology

235. A key objective of environmental education is to develop an citizenry that is:
(A) Unquestioningly supportive of all industrial development.
(B) Focused only on local environmental issues.
(C) Able to recite complex chemical formulas.
(D) Environmentally aware and willing to act.

236. What is the fundamental unit of analysis in raster GIS?
(A) A point
(B) A pixel or cell
(C) A line
(D) A polygon

237. The total mass of living or formerly living material within a given area is referred to as:
(A) Biosphere
(B) Biome
(C) Biomass
(D) Biocentrism

238. Given below are two statements:
Statement I : The laws of thermodynamics govern all energy and mass transfers in the environment.
Statement II : The study of thermodynamics is therefore irrelevant to environmental science.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Statement I is correct, but Statement II is incorrect.
(C) Statement I is incorrect, but Statement II is correct.
(D) Both Statement I and Statement II are incorrect.

239. The concept of dividing India into specific agro-climatic zones helps in:
(A) Developing region-specific agricultural strategies.
(B) Creating more states and union territories.
(C) Redrawing international boundaries.
(D) Promoting a single crop across the entire country.

240. Which of these is an example of an interface where mass and energy transfer is studied in environmental science?
(A) The boundary between two pages in a book.
(B) The air-water interface at the surface of a lake.
(C) The user interface of a computer program.
(D) The interface between two different software applications.

241. A satellite with a high temporal resolution would be most suitable for:
(A) Creating a one-time, highly detailed map of a city.
(B) Monitoring a rapidly changing event, such as a flood.
(C) Identifying different types of minerals in rocks.
(D) Measuring the precise elevation of a mountain.

242. What are our moral duties to future generations with respect to the environment? This is a central question in:
(A) Environmental ethics
(B) Environmental meteorology
(C) Remote sensing
(D) Digital image processing

243. If the Environmental Lapse Rate (ELR) is less than the Saturated Adiabatic Lapse Rate (SALR), the atmosphere is said to be:
(A) Absolutely unstable
(B) Conditionally unstable
(C) Absolutely stable
(D) Neutral

244. The lithosphere is primarily studied within the field of:
(A) Meteorology
(B) Hydrology
(C) Biology

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(D) Geology

245. The principle of sustainability is best described as:
(A) A scientific law proven by experimentation.
(B) A method for calculating pollution levels.
(C) An ethical guideline for human behavior towards the environment.
(D) A technique for remote sensing.

246. In the context of environmental science, the hydrosphere includes:
(A) Only the oceans.
(B) Water in all its forms (solid, liquid, gas) on, under, and over the Earth's surface.
(C) Only liquid water.
(D) Only the water present in the atmosphere.

247. The statement that energy can be transferred or transformed, but it cannot be created or destroyed is the:
(A) Second Law of Thermodynamics
(B) Law of Conservation of Mass
(C) Principle of Sustainable Development
(D) First Law of Thermodynamics

248. The application of remote sensing and GIS in land cover/land use planning is crucial for:
(A) Monitoring changes in the landscape and informing sustainable management decisions.
(B) Understanding the chemical composition of the atmosphere.
(C) Calculating the exact age of the Earth.
(D) Enforcing international treaties on human rights.

249. Which of the following defines the scope of Environmental Science most accurately?
(A) It is limited to the study of plants and animals.
(B) It is solely concerned with the politics of environmental protection.
(C) It is a comprehensive field studying the interactions among physical, chemical, and biological components of the environment.
(D) It focuses only on the impact of technology on society.

250. The process of heat transfer by molecular activity, from one substance to another or through a substance, is called:
(A) Conduction
(B) Convection
(C) Radiation
(D) Advection

Direction : Please read the following source carefully.

Environmental Science is fundamentally an interdisciplinary academic field that integrates physical, biological, and information sciences to study the environment and the solution of environmental problems. Its core principles revolve around the interconnected ness of natural systems, the flow of energy, and the cycling of matter. A key principle is that everything is connected to everything else, emphasizing the complex feedback loops within ecosystems. Another foundational principle is that there is no 'away' for waste materials, highlighting the law of conservation of matter and the importance of material balance in environmental management. The scope of Environmental Science is exceptionally broad, encompassing not only the scientific understanding of the Earth's spheres—atmosphere, hydrosphere, lithosphere, and biosphere—but also the social, economic, and political dimensions of human-environment interactions. It addresses critical issues such as pollution, resource depletion, climate change, and biodiversity loss, seeking to foster a transition towards sustainable development. This requires a holistic approach, drawing knowledge from fields as diverse as ecology, geology, chemistry, geography, sociology, and economics to formulate effective policies and management strategies. The discipline's ultimate aim is to understand how the natural world works and how human systems interact with it, in order to manage our environment wisely.

Based on the above source, attempt the following five questions.

251. Which statement best encapsulates the primary focus of Environmental Science as described in the paragraph?
(A) The exclusive study of biological organisms and their life cycles.
(B) The integration of multiple scientific

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disciplines to understand and solve environmental issues.
(C) The economic valuation of natural resources for industrial use.
(D) The political processes involved in creating international environmental treaties.

252. The principle there is no 'away' for waste materials is a direct consequence of which fundamental concept mentioned in the text?
(A) The principle of material balance.
(B) The interconnected ness of natural systems.
(C) The broad scope of environmental science.
(D) The social dimensions of environmental interactions.

253. According to the passage, the scope of Environmental Science extends beyond the natural sciences to include:
(A) only the study of the Earth's physical spheres.
(B) primarily the principles of thermodynamics and energy transfer.
(C) the social, economic, and political aspects of human-environment relationships.
(D) a narrow focus on pollution control technologies.

254. What can be inferred about the approach required to address complex environmental problems like climate change, based on the source?
(A) A singular focus on chemistry is sufficient.
(B) Economic considerations should be prioritized over ecological ones.
(C) Technological solutions alone are the key.
(D) A holistic and interdisciplinary approach is necessary.

255. The text suggests that a major goal of Environmental Science is to:
(A) promote the unlimited exploitation of natural resources.
(B) document the history of environmental degradation without proposing solutions.
(C) understand natural systems to facilitate wise environmental management.
(D) separate the study of human systems from natural systems.

Direction : Please read the following source carefully.

The Earth's environment is composed of four primary structural components: the atmosphere, hydrosphere, lithosphere, and biosphere, each with a distinct structure and composition. The atmosphere, the gaseous envelope surrounding the planet, is stratified into layers based on temperature profiles, including the troposphere, stratosphere, mesosphere, and thermosphere. Its composition is predominantly nitrogen (approx. 78%) and oxygen (approx. 21%), with trace amounts of argon, carbon dioxide, and other gases that play crucial roles in the planet's climate system. The hydrosphere encompasses all water on Earth, including oceans, seas, lakes, rivers, glaciers, and groundwater. About 97.5% of this water is saline, found in oceans, while the remaining 2.5% is freshwater, a significant portion of which is locked in ice caps and glaciers. The lithosphere is the rigid, outermost shell of the Earth, consisting of the crust and the upper mantle. It is fragmented into tectonic plates and is primarily composed of rocks and minerals, forming the landmasses and ocean floors. The biosphere represents the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, hydrosphere, and atmosphere. This zone of life is not a separate sphere but a composite system that overlaps with the other three, extending from the deep ocean floors to the lower atmosphere.

Based on the above source, attempt the following five questions.

256. Which layer of the atmosphere is not explicitly mentioned by name in the paragraph's description of atmospheric stratification?
(A) Troposphere
(B) Exosphere
(C) Stratosphere
(D) Mesosphere

257. Based on the composition of the atmosphere described, what is the approximate combined percentage of nitrogen and oxygen?
(A) 21%
(B) 78%
(C) 100%
(D) 99%

258. What does the source imply about the availability of freshwater for human use and ecosystems?
(A) It constitutes a very small fraction of the total hydrosphere and is largely inaccessible.
(B) It is abundant and mostly found in rivers and lakes.
(C) It is primarily saline and requires extensive desalination.
(D) It is evenly distributed across the globe in liquid form.

259. The passage defines the biosphere as a system that:
(A) is entirely separate and distinct from the other three spheres.
(B) consists only of the planet's plant life and vegetation.
(C) is a composite zone of life overlapping with the atmosphere, hydrosphere, and lithosphere.
(D) is located exclusively within the Earth's crust and lithosphere.

260. The lithosphere is described as comprising which two components?
(A) The crust and the upper mantle.
(B) The atmosphere and the hydrosphere.
(C) The lower mantle and the outer core.
(D) The oceans and the continents.

Direction : Please read the following source carefully.

The functioning of all environmental systems is governed by fundamental physical principles, particularly the laws of thermodynamics, which dictate the nature of energy and mass transfer. The First Law of Thermodynamics, or the law of conservation of energy, states that energy cannot be created or destroyed, only transformed from one form to another. In an ecosystem, this means that all energy, primarily from the sun, is conserved as it flows through different trophic levels. The Second Law of Thermodynamics introduces the concept of entropy, suggesting that during any energy transformation, some energy is converted into a less useful form, typically heat, leading to increased disorder in the system. This explains why energy flow in an ecosystem is unidirectional and why energy pyramids are always upright. Complementing these laws are the primary heat transfer processes: conduction, convection, and radiation. Radiation is the transfer of energy through electromagnetic waves, like solar energy reaching Earth. Conduction is the transfer of heat through direct contact, while convection is heat transfer through the movement of fluids (liquids or gases). Furthermore, the principle of material balance, an application of the law of conservation of mass, is crucial for environmental analysis. It posits that mass entering a system must, over time, either leave the system or accumulate within it, providing a framework for tracking pollutants and nutrients across various interfaces.

Based on the above source, attempt the following five questions.

261. The unidirectional flow of energy through an ecosystem, with a loss of useful energy at each trophic level, is best explained by which law?
(A) The First Law of Thermodynamics
(B) The law of conservation of mass
(C) The principle of material balance
(D) The Second Law of Thermodynamics

262. The concept of material balance, used for tracking pollutants, is an application of which fundamental principle?
(A) The law of conservation of energy.
(B) The law of conservation of mass.
(C) The increase of entropy in a closed system.
(D) The process of heat transfer by convection.

263. According to the passage, solar energy reaching the Earth is an example of which heat transfer process?
(A) Conduction
(B) Convection
(C) Radiation
(D) Advection

264. What can be inferred from the First Law of Thermodynamics in the context of an ecosystem?
(A) Energy is lost completely as it moves up the food chain.
(B) New energy is continuously created at the producer level.
(C) The system naturally tends towards a state of maximum order.
(D) The total amount of energy remains constant as it changes form within the system.

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265. Heat transfer occurring through the movement of air masses in the atmosphere is a classic example of:
(A) convection, as it involves the movement of a fluid.
(B) conduction, as molecules are in direct contact.
(C) radiation, as energy travels through space.
(D) entropy, as it represents a loss of useful heat.

Direction : Please read the following source carefully.

Understanding weather and climate requires the measurement and analysis of key meteorological parameters. Atmospheric pressure, the force exerted by the weight of the air above, is a fundamental indicator of weather changes. Temperature, a measure of the average kinetic energy of air molecules, dictates the rate of many atmospheric processes. Precipitation includes all forms of water—liquid or solid—that fall from the atmosphere and reach the Earth's surface. Humidity refers to the amount of water vapor in the air, a critical factor for cloud formation and human comfort. This is often quantified by the mixing ratio, the mass of water vapor per unit mass of dry air, and the saturation mixing ratio, which is the maximum amount of water vapor that air can hold at a specific temperature and pressure. The vertical temperature profile of the atmosphere is described by lapse rates. The environmental lapse rate (ELR) is the actual rate of temperature decrease with an increase in altitude for a given location and time. In contrast, the adiabatic lapse rate (ALR) refers to the rate of temperature change in a parcel of air as it rises or sinks, without any heat exchange with its surroundings. The relationship between the ELR and ALR determines atmospheric stability, influencing vertical air motion and potential for storm development.

Based on the above source, attempt the following five questions.

266. Which parameter is defined as the maximum amount of water vapor that a unit of air can hold at a given temperature?
(A) Mixing ratio
(B) Saturation mixing ratio
(C) Humidity
(D) Precipitation

267. The stability of the atmosphere, which influences vertical air movement, is determined by comparing which two parameters?
(A) Atmospheric pressure and air temperature.
(B) The environmental lapse rate and the adiabatic lapse rate.
(C) The mixing ratio and the saturation mixing ratio.
(D) Precipitation levels and ambient humidity.

268. According to the text, the adiabatic lapse rate describes a temperature change in a parcel of air under what specific condition?
(A) When there is no heat exchange with the surrounding environment.
(B) When there is significant heat exchange with the surrounding air.
(C) When the air parcel remains at a constant altitude.
(D) When the air parcel's pressure remains constant.

269. Based on the description, what is the fundamental difference between the 'mixing ratio' and 'humidity'?
(A) There is no difference; the terms are synonymous.
(B) Mixing ratio measures liquid water, while humidity measures water vapor.
(C) Humidity is a general term, while mixing ratio is a specific quantitative measure of water vapor relative to dry air.
(D) Humidity is measured in pascals, while mixing ratio is a percentage.

270. What can be inferred about a situation where the environmental lapse rate is significantly greater than the adiabatic lapse rate?
(A) The atmosphere is likely to be very stable.
(B) There will be no cloud formation.
(C) The temperature will increase with altitude.
(D) The atmosphere is likely to be unstable, promoting vertical air motion.

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Direction : Please read the following source carefully.

In meteorology and environmental science, wind is a crucial parameter described by both speed and direction. Wind velocity is a vector quantity, meaning it has both magnitude (speed) and direction. While wind speed can be measured using

an anemometer, a comprehensive representation of wind characteristics over time at a specific location is best achieved through a graphical tool known as a wind rose. A wind rose provides a succinct visual summary of how wind speed and direction are distributed over a predefined period. The chart typically consists of a circle from which a series of bars or spokes radiate, corresponding to different compass directions (e.g., North, NNE, NE). The length of each spoke is proportional to the frequency with which the wind blows from that particular direction. Furthermore, the spokes can be color-coded or subdivided into segments to represent different wind speed ranges. For instance, a long bar pointing to the northwest indicates that the wind blew from the northwest more frequently than from other directions. By analyzing a wind rose, one can quickly identify the prevailing wind direction, which is critical for various applications, including airport runway design, positioning of wind turbines, industrial site selection to minimize pollution dispersion towards populated areas, and architectural planning.

Based on the above source, attempt the following five questions.

271. What is the primary function of a wind rose?
(A) To measure the instantaneous wind speed at a given moment.
(B) To illustrate the global circulation of atmospheric winds.
(C) To provide a graphical summary of wind speed and direction distribution over a period.
(D) To predict future wind patterns using thermodynamic laws.

272. The length of a spoke on a wind rose a-typically represents which attribute of the wind?
(A) The maximum recorded wind speed from that direction.
(B) The frequency of wind blowing from that direction.
(C) The average temperature of the wind from that direction.
(D) The barometric pressure associated with that direction.

273. Why is wind velocity considered a vector quantity?
(A) Because it is measured using a complex instrument.
(B) Because its value changes continuously over time.
(C) Because it is influenced by atmospheric pressure.
(D) Because it possesses both magnitude (speed) and direction.

274. Based on the passage, identifying the prevailing wind direction from a wind rose would be most critical for which of the following applications?
(A) Planning the orientation of an airport runway.
(B) Determining the saturation mixing ratio of the air.
(C) Calculating the environmental lapse rate.
(D) Measuring the daily precipitation amount.

275. If a wind rose for a coastal city showed very long spokes pointing from the southeast, what could be inferred?
(A) The wind rarely blows from the southeast.
(B) The strongest winds always come from the northwest.
(C) The prevailing winds in that city are from the southeast.
(D) The city experiences calm conditions most of the time.

Direction : Please read the following source carefully.

The relationship between Earth, Man, and Environment is a complex, dynamic interaction that has evolved significantly over time. Human societies depend on the Earth's systems for resources and life support, but their activities also induce profound environmental changes. To better understand and manage these interactions on a spatial basis, the world has been categorized into biogeographic provinces. These are large areas of the Earth's surface where organisms have been evolving in relative isolation over long periods, separated by geographic barriers such as oceans, broad deserts, or high mountain ranges. Each province is characterized by its unique assemblage of endemic species. On a national scale, India is divided into various agro-climatic zones, which are defined based on key parameters like rainfall, temperature, and soil type to delineate areas with similar agricultural potentials and constraints.

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This zonation helps in developing region-specific agricultural strategies. Recognizing the often-detrimental impact of human activities on the environment, the concept of sustainable development has emerged as a guiding principle. It advocates for development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This concept seeks to harmonize the three pillars of societal progress: economic viability, social equity, and environmental protection, thereby fostering a balanced interaction between man and environment.

Based on the above source, attempt the following five questions.

276. What is the primary basis for demarcating biogeographic provinces?
(A) Long-term evolutionary isolation and unique species assemblages.
(B) Political boundaries and national borders.
(C) Economic activity and industrial development.
(D) Uniform climate and temperature across the region.

277. The division of India into agro-climatic zones primarily serves to:
(A) create new states and administrative districts.
(B) promote industrial growth in specific regions.
(C) demarcate areas based on their endemic wildlife species.
(D) develop targeted agricultural strategies based on regional environmental conditions.

278. The concept of sustainable development, as described in the passage, aims to balance which three core elements?
(A) Technology, industry, and urbanization.
(B) Economic viability, social equity, and environmental protection.
(C) Past, present, and future needs.
(D) Individual, community, and national interests.

279. What can be inferred about the relationship between humans and the environment from the text?
(A) It is a one-way relationship where the environment only affects humans.
(B) It is a static and unchanging relationship over time.
(C) It is a reciprocal relationship where human actions impact the environment that supports them.
(D) Human activities have had a universally positive impact on the environment.

280. The central tenet of sustainable development, meeting the needs of the present without compromising the ability of future generations to meet their own needs, highlights the importance of:
(A) rapid economic growth at all costs.
(B) ceasing all forms of development immediately.
(C) prioritizing the needs of the present over any future considerations.
(D) inter-generational equity and long-term resource management.

Direction : Please read the following source carefully.

The assessment and management of natural resources are foundational to environmental science and sustainable development. A critical component of this process is the use of modern geospatial technologies like Remote Sensing (RS) and Geographic Information Systems (GIS). The core principle of remote sensing is the acquisition of information about an object or phenomenon without making physical contact with it. This is typically achieved by detecting and measuring the radiation (usually electromagnetic) that is reflected or emitted from the object's surface. Sensors mounted on platforms like satellites or aircraft capture this data, which provides a synoptic view of large areas of the Earth's surface. A Geographic Information System (GIS), on the other hand, is a computer-based framework designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. GIS integrates various data layers (e.g., land use, soil type, elevation) and allows for complex spatial queries and analyses. The true power of these technologies is often realized when they are used together. Remotely sensed imagery serves as a primary data source for a GIS, providing up-to-date information about land cover, vegetation health, and surface

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water, which can then be analyzed within the GIS environment to support decision-making in natural resource management.

Based on the above source, attempt the following five questions.

281. What is the fundamental principle of remote sensing?
(A) Acquiring information about an object without direct physical contact.
(B) Physical sample collection and laboratory analysis.
(C) Creating digital maps using cartographic techniques.
(D) The management and storage of geographical data in layers.

282. According to the text, a Geographic Information System (GIS) is best described as a:
(A) satellite that captures images of the Earth.
(B) system for analyzing and managing spatial data.
(C) sensor that measures reflected electromagnetic radiation.
(D) method for conducting ground-based surveys.

283. How do Remote Sensing and GIS typically complement each other in natural resource management?
(A) GIS is used to correct errors in remote sensing platforms.
(B) Remote sensing provides data that is analyzed within a GIS framework.
(C) They are independent technologies with no functional overlap.
(D) GIS is used to launch satellites for remote sensing.

284. The radiation detected by remote sensing sensors is described as being:
(A) reflected or emitted from the surface of an object.
(B) exclusively sound waves emitted from the Earth's core.
(C) only visible light reflected from man-made objects.
(D) a fictional concept used in data modeling.

285. The passage suggests that a key advantage of using satellite-based remote sensing is its ability to:
(A) provide a detailed chemical analysis of soil samples.
(B) replace the need for all forms of ground-level data collection.
(C) offer a synoptic view, or wide-area coverage, of the Earth's surface.
(D) directly measure the economic value of natural resources.

Direction : Please read the following source carefully.

The raw data acquired through remote sensing requires significant processing before it can be effectively used for analysis. This process is known as digital image processing, which involves the manipulation of digital images using computer algorithms to enhance image quality and extract useful information. Key steps include radiometric and geometric corrections to remove sensor-induced distortions and atmospheric effects. Following these corrections, images can be enhanced for better visual interpretation or classified into thematic maps, such as land cover maps. However, the information derived from satellite imagery is not always perfectly accurate. Therefore, a crucial validation step known as ground truthing is essential. Ground truthing involves acquiring field data from the surface of the Earth to be compared with the information derived from the remotely sensed data. This can involve visiting specific locations to identify the actual land cover type (e.g., confirming a pixel classified as 'forest' is indeed a forest) or measuring biophysical parameters on the ground. This process is vital for assessing the accuracy of image classification and calibrating interpretation models. The applications of this integrated approach are vast, particularly in land cover and land use planning. It is instrumental in monitoring dynamic processes like urban sprawling, studying vegetation health and distribution, supporting forestry management, and conducting inventories of natural resources.

Based on the above source, attempt the following five questions.

286. What is the primary purpose of ground truthing in the context of remote sensing?

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(A) To launch the satellite into the correct orbit.
(B) To process the digital image using computer algorithms.
(C) To perform the initial geometric corrections on the raw data.
(D) To validate and assess the accuracy of information derived from imagery.

287. Digital image processing, as described in the passage, includes which of the following activities?
(A) Collecting field data from the Earth's surface.
(B) Mounting sensors on satellite platforms.
(C) Correcting images for distortions and classifying them into themes.
(D) Designing the hardware for remote sensing satellites.

288. According to the text, monitoring urban sprawling is a direct application of:
(A) ground truthing exclusively.
(B) the integrated use of remote sensing and GIS.
(C) radiometric correction algorithms only.
(D) the principles of thermodynamics.

289. What can be inferred about the raw data obtained from remote sensing satellites?
(A) It is perfectly accurate and ready for immediate use.
(B) It consists primarily of ground-based survey measurements.
(C) It cannot be used for studying vegetation or forestry.
(D) It contains distortions that need to be corrected through digital image processing.

290. An environmental manager wants to create an accurate map of different forest types in a large, inaccessible mountain range. Based on the passage, what would be the most effective methodology?
(A) Classifying satellite imagery and then using targeted ground truthing to verify the classification.
(B) Relying solely on historical paper maps of the region.
(C) Conducting a comprehensive foot survey of the entire mountain range.
(D) Using GIS to generate a map without any input data from remote sensing.

Direction : Please read the following source carefully.

Beyond general land use planning, the application of Remote Sensing (RS) and Geographic Information Systems (GIS) extends to highly specialized and critical areas of environmental management, such as waste management and the study of climate change. In waste management, these technologies are pivotal for the entire lifecycle of waste disposal facilities. For instance, GIS can be used for optimal site selection for new landfills by integrating multiple data layers, including topography, proximity to residential areas, groundwater depth, and soil type, to identify locations that minimize environmental risk and social impact. Remote sensing can then be used to monitor the operational status of landfills, detect illegal dumping sites, and assess the environmental impact on surrounding areas over time, for instance, by observing changes in vegetation health. In the context of climate change, RS and GIS are indispensable tools for monitoring and modeling global environmental shifts. Satellites continuously monitor key climate variables like sea surface temperature, polar ice extent, glacier retreat, and changes in large-scale vegetation patterns (e.g., desertification or deforestation). This vast repository of spatial-temporal data, when analyzed within a GIS, allows scientists to quantify the rate of these changes, validate climate models, and assess the vulnerability of different regions to climate change impacts like sea-level rise.

Based on the above source, attempt the following five questions.

291. In the context of waste management, how does GIS aid in the site selection for landfills?
(A) By physically collecting and disposing of waste.
(B) By generating the energy from waste products.
(C) By integrating various spatial data layers to identify optimal, low-risk locations.
(D) By exclusively monitoring air pollution from existing landfills.

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292. Which of the following is an application of remote sensing in monitoring climate change, as mentioned in the passage?
(A) Measuring the retreat of glaciers and polar ice extent.
(B) Regulating greenhouse gas emissions from industries.
(C) Formulating international climate policy.
(D) Conducting social surveys on climate change perception.

293. According to the passage, how can remote sensing be used to monitor the impact of a landfill on its surroundings?
(A) By measuring the economic output of the local area.
(B) By analyzing the chemical composition of the waste.
(C) By interviewing residents living near the landfill.
(D) By observing changes in the health of surrounding vegetation.

294. The passage suggests that the main contribution of RS and GIS to climate change studies is:
(A) developing new sources of renewable energy.
(B) providing and analyzing large-scale spatial data to monitor and quantify global changes.
(C) directly reducing the amount of carbon dioxide in the atmosphere.
(D) funding climate adaptation projects in developing nations.

295. A planner using GIS to find a suitable landfill site would likely consider proximity to residential areas as what kind of factor?
(A) A factor to be maximized.
(B) An irrelevant data layer.
(C) A constraint or a factor to be minimized.
(D) The only factor of importance.

Direction : Please read the following source carefully.

A comprehensive approach to environmental stewardship involves not only scientific understanding and technological solutions but also the cultivation of public consciousness and ethical frameworks. Environmental education and awareness are critical components in this endeavor. The primary goal of environmental education is to impart knowledge about the environment's functioning, create awareness of environmental issues, and foster the attitudes, skills, and motivations necessary for individuals and communities to participate in environmental protection and problem-solving. It aims to transform awareness into pro-environmental behavior. Closely linked to this is the field of environmental ethics, a branch of philosophy that examines the moral relationship between human beings and the natural world. It addresses fundamental questions about what value, if any, non-human entities possess and what moral duties humans have towards the environment. Ethical perspectives range from anthropocentrism, which grants moral standing exclusively to humans, to non-anthropocentric views like biocentrism (value in all living things) and ecocentrism (value in whole ecosystems). These ethical considerations are not merely academic; they profoundly influence societal values, individual choices, and the formulation of environmental policies, shaping our collective responsibility towards preserving the planet for current and future generations.

Based on the above source, attempt the following five questions.

296. What is the ultimate goal of environmental education as described in the passage?
(A) To exclusively teach scientific facts about the environment.
(B) To promote a purely human-centered view of the world.
(C) To train specialists only for the field of environmental law.
(D) To encourage active participation in environmental protection.

297. Environmental ethics is primarily concerned with:
(A) the moral relationship between humans and the natural environment.
(B) the economic cost of environmental regulations.
(C) the scientific classification of species.
(D) the technological methods for pollution control.

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298. An ethical perspective that assigns intrinsic value to entire ecosystems, not just individual organisms, would be best described as:
(A) anthropocentrism.
(B) ecocentrism.
(C) technocentrism.
(D) economic utilitarianism.

299. According to the passage, how do environmental education and environmental ethics relate to each other?
(A) They are opposing fields with conflicting goals.
(B) Environmental ethics provides the moral foundation that environmental education seeks to foster in society.
(C) Environmental education is a science, whereas environmental ethics has no practical application.
(D) They are identical concepts referred to by different names.

300. A policy argument that a forest should be preserved only because of its value as timber and a recreational resource for people would be an example of which ethical viewpoint?
(A) Anthropocentrism
(B) Biocentrism
(C) Ecocentrism
(D) Preservationism

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ANSWERS

1. (B) The scientific study of our environment and our role in it.
Interdisciplinary study of physical, chemical, and biological surroundings. Examines relationships between humans and the natural world. Integrates diverse fields like ecology, geology, and sociology to solve environmental problems. The focus remains on understanding system dynamics, identifying impacts of human activities, and developing sustainable solutions. This scientific approach helps in managing resources and protecting the biosphere through evidence-based research and policy.

2. (A) The Principle of Holism
This approach views environmental systems as integrated wholes rather than just a collection of separate parts. It emphasizes that the properties of a system cannot be determined by its component parts alone. Instead, the system as a whole determines how the parts behave. This perspective is crucial for understanding complex ecological interactions where the entire network influences individual survival and overall stability.

3. (D) Statement I is incorrect, but Statement II is correct.
Environmental Science is not restricted to pollution studies but serves as a broad interdisciplinary field. It synthesizes knowledge from natural sciences like biology and chemistry alongside social sciences and humanities. This comprehensive approach is necessary because environmental issues involve complex interactions between physical processes and human societal structures. Understanding these connections allows for more effective management of natural resources and sustainable development strategies.

4. (D) Troposphere
The troposphere is the lowest atmospheric layer, extending from the surface to about ten kilometers. It contains the majority of the atmosphere's mass, including water vapor and aerosols. Most weather processes, such as cloud formation and precipitation, occur here because of the high concentration of moisture. Temperature typically decreases with altitude in this layer, driven by the heating of the Earth's surface.

5. (C) Nitrogen
Nitrogen constitutes approximately seventy-eight percent of the Earth's atmosphere by volume, making it the most abundant gas. Although it is relatively inert in its diatomic form, it is essential for all living organisms as a building block of proteins and DNA. Other major components include oxygen at twenty-one percent, followed by argon and carbon dioxide, which exist in much smaller trace amounts.

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6. (B) Temperature increases with altitude throughout the mesosphere.
In the mesosphere, temperature actually decreases as altitude increases, reaching the coldest temperatures in the entire atmosphere. This layer extends from the stratopause to the mesopause. The decrease occurs because there is little solar radiation absorption compared to the layers below and above. Misconceptions often arise because the stratosphere below and the thermosphere above both experience temperature increases with altitude due to specific heating mechanisms.

7. (A) P-4, Q-1, R-3, S-2
The Earth is organized into four main interacting spheres. The hydrosphere encompasses all liquid and frozen water found on the planet. The lithosphere consists of the solid outer shell, including the crust and upper mantle. The atmosphere contains the gaseous envelope surrounding the Earth, while the biosphere includes all regions inhabited by living organisms. These spheres are interconnected through the cycling of matter and energy.

8. (A) The conservation of energy
The first law states that energy is neither created nor destroyed, only transformed from one form to another. In environmental systems, this principle

is used to track energy flows through ecosystems and industrial processes. For example, solar energy captured by plants is converted into chemical energy rather than vanishing. This conservation principle forms the basis for energy budgets and understanding how systems maintain their internal balance.

9. (C) Convection
Convection is the primary mechanism for heat transfer in fluids, including liquids and gases. It involves the physical movement of the fluid itself, where warmer, less dense portions rise and cooler, denser portions sink. This process creates circulation patterns that distribute thermal energy throughout the medium. In the atmosphere, convection is responsible for vertical air movements, the formation of clouds, and various weather phenomena.

10. (A) Some energy is always lost as low-quality heat.
According to the second law, every energy transfer or transformation increases the total entropy of the universe. This means that no process is perfectly efficient, as some energy is always dissipated as low-quality, disorganized heat. In ecosystems, this explains why energy decreases at higher trophic levels. Only a fraction of the energy consumed by an organism is available to the next consumer in the chain.

11. (A) (a) and (b) only
The hydrosphere encompasses all forms of water, including atmospheric vapor, oceans, and ice. The lithosphere is the rigid outer layer consisting of the crust and the brittle upper mantle. These spheres are dynamic and interact constantly with the biosphere and atmosphere. Contrary to some myths, the biosphere depends entirely on these interactions, and the atmosphere's composition has evolved significantly over geological time due to biological activity.

12. (B) Material Balance
Material balance is a fundamental application of the law of conservation of mass. It involves accounting for all inputs, outputs, and internal changes of a substance within a specific system. Environmental scientists use this tool to track the movement and concentration of pollutants in water bodies or air. By calculating the mass entering and leaving a river, they can predict downstream concentrations and evaluate environmental impacts.

13. (C) Mixing ratio
The mixing ratio is a precise meteorological term defined as the mass of water vapor divided by the mass of dry air in a given volume. It is typically expressed in units of grams of vapor per kilogram of dry air. Unlike relative humidity, the mixing ratio remains constant unless moisture is added or removed, making it a valuable measure for tracking air masses and moisture content.

14. (A) Both A and R are true and R is the correct explanation of A.
Temperature increases with altitude in the stratosphere because of the ozone layer. Ozone molecules absorb high-energy ultraviolet radiation from the sun, converting this energy into heat. This absorption creates a thermal inversion that prevents vertical mixing with the troposphere below. Consequently, the stratosphere is characterized by stability and increasing warmth, which is essential for protecting life on Earth from harmful solar radiation.

15. (A) Adiabatic Lapse Rate (ALR)
The adiabatic lapse rate describes the rate at which the temperature of a rising or sinking air parcel changes without exchanging heat with its surroundings. For unsaturated air, this is known as the dry adiabatic lapse rate. As the parcel rises into lower pressure, it expands and cools. This internal energy change is fundamental to atmospheric stability analysis and predicting whether air will continue to rise.

16. (B) Unstable
An atmosphere is considered unstable when the environmental lapse rate exceeds the adiabatic lapse rate. In this condition, a rising air parcel remains warmer and less dense than the surrounding ambient air at all altitudes. This temperature difference provides buoyancy, causing the air to continue rising autonomously. Unstable conditions often lead to significant vertical mixing, the formation of convective clouds, and potentially severe weather.

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17. (B) Wind speed and wind direction at a specific location.
A wind rose is a specialized circular graphic used to summarize the wind conditions at a specific location over a period. It displays the frequency and speed of winds coming from different cardinal directions. The length of each spoke indicates how often the wind blows from that direction, while colors or segments represent speed ranges. This tool is essential for site analysis in meteorology and engineering.

18. (B) (b), (d), (a), (c)
The Earth's atmosphere is organized into distinct layers based on temperature trends. Starting from the surface, the troposphere is the first layer where most weather occurs. Above it lies the stratosphere, which contains the protective ozone layer. The mesosphere follows, representing the coldest region. Finally, the thermosphere is the outermost layer, characterized by increasing temperatures due to the absorption of high-energy solar radiation by gases.

19. (C) The Brundtland Commission Report ('Our Common Future').
The concept of sustainable development gained global prominence through the 1987 report titled Our Common Future, produced by the World Commission on Environment and Development. Chaired by Gro Harlem Brundtland, the commission defined the term as development meeting present needs without compromising future generations. This landmark document shifted the international focus toward balancing economic growth with social equity and environmental protection on a long-term scale.

20. (D) Political stability
Sustainable development is traditionally built upon three foundational pillars: environmental protection, social equity, and economic viability. These components are interdependent and must be balanced to achieve long-term global stability. Environmental protection ensures resource availability, social equity promotes fairness and human rights, and economic viability provides the necessary means for societal improvement. Political stability, while often a result or requirement, is not categorized as a core pillar.

21. (C) Biosphere - Only non-living components
The biosphere is the global ecological system integrating all living beings and their relationships with the lithosphere, hydrosphere, and atmosphere. It is defined specifically by the presence of life and the biological processes that occur within it. Stating that the biosphere consists only of non-living components is factually incorrect, as it is fundamentally the zone of life. It encompasses everything from deep-sea organisms to high-altitude birds.

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22. (B) Anthropocentrism
Anthropocentrism is a human-centered philosophical viewpoint that considers human beings as the most significant entities in the universe. In this perspective, the natural world is valued primarily for its utility to humans. Nature is often viewed as a resource to be managed and exploited for human benefit. This ethical framework contrasts with ecocentrism and biocentrism, which assign intrinsic value to non-human life and whole ecological systems.

23. (D) Rainfall, temperature, and specific soil characteristics.
Agro-climatic zones in India are delineated based on regional variations in climate and physical geography. The primary criteria used for this classification include rainfall patterns, temperature ranges, and soil characteristics. By grouping areas with similar environmental conditions, the system allows for better agricultural planning, resource management, and crop selection tailored to local constraints. This scientific approach helps optimize food production and ensures more sustainable land use.

24. (A) It detects electromagnetic radiation reflected or emitted from an object.
Remote sensing is the science of acquiring information about the Earth's surface from a distance, typically using satellites or aircraft. It relies on detecting and measuring electromagnetic radiation that is either reflected or emitted by objects. This process does not require direct physical contact with the study area. Sensors can capture data across various wavelengths, including the visible, infrared, and microwave regions of the electromagnetic spectrum.

25. (B) (b), (c), and (e) only

Geographic Information Systems integrate hardware, software, and data to manage spatial information. They utilize two primary data models: raster, which uses grid cells, and vector, which uses points, lines, and polygons. GIS allows users to perform complex spatial analysis to uncover patterns and relationships in geographic data. Contrary to simple mapping, it is a comprehensive system involving people and methods to facilitate informed decision-making across various professional fields.

26. (A) The collection of ground-level data to verify remote sensing information.
Ground truthing is the process of collecting on-site data to verify and calibrate information derived from remote sensing. By visiting specific locations on the Earth's surface, researchers can confirm whether the land cover identified in satellite imagery accurately reflects reality. This practice is essential for assessing the accuracy of digital classifications and ensuring that the final maps produced via Geographic Information Systems are reliable for analysis.

27. (D) Enhancing and classifying satellite images to extract information.
Digital Image Processing involves using computer algorithms to manipulate and analyze satellite or aerial imagery. Its primary goal is to enhance the visual quality of images and extract meaningful information through classification. This includes correcting geometric distortions, reducing noise, and identifying different land cover types based on spectral signatures. DIP is a crucial step in transforming raw sensor data into actionable geographic knowledge for environmental monitoring and planning.

28. (A) Both Statement I and Statement II are correct.
Environmental education focuses on building public awareness and understanding of ecological issues to foster responsible behavior. Parallel to this, environmental ethics is a philosophical branch that examines the moral duties humans have toward the natural world. Both fields are essential for addressing environmental challenges. While education provides the knowledge necessary for action, ethics provides the values and reasoning that guide how society chooses to interact with the environment.

29. (C) Biocentrism
Biocentrism is an ethical perspective that grants moral standing to all living organisms regardless of their utility to humans. It suggests that all life forms have intrinsic value and deserve respect and protection. This viewpoint shifts the focus away from human interests alone, advocating for a broader moral community that includes animals and plants. It contrasts with anthropocentrism, which values nature only as a means to satisfy human needs.

30. (D) Monitoring and analyzing urban sprawling over time.
Remote sensing and Geographic Information Systems are powerful tools for monitoring urban sprawl, which is the uncontrolled expansion of cities into surrounding rural areas. By comparing satellite images from different time periods, planners can quantify land-use changes and identify patterns of development. This spatial analysis helps in designing more sustainable urban growth strategies, protecting agricultural land, and managing the increasing demand for infrastructure and public services in expanding cities.

31. (A) P-4, Q-3, R-1, S-2
Meteorological parameters are measured using standardized units to ensure scientific consistency. Atmospheric pressure is typically expressed in Pascals or millibars. Wind velocity is measured in meters per second or knots, capturing both speed and direction. Precipitation is recorded in millimeters or centimeters, representing the depth of water collected. Solar radiation intensity is measured in Watts per square meter, reflecting the amount of energy reaching a specific surface area.

32. (B) Between systems like air-water, water-sediment, and soil-air interfaces.
Environmental science examines the movement of mass and energy across various boundaries, known as interfaces. These include the air-water interface, where evaporation and gas exchange occur, and the soil-air interface, involving moisture and nutrient movement. Such processes are fundamental to the global cycles of water, carbon, and heat. Understanding these interactions at local and global scales is

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essential for predicting environmental changes and managing natural ecosystems effectively.

33. (B) First Law of Thermodynamics
The first law of thermodynamics, also known as the law of conservation of energy, states that energy cannot be created or destroyed. It can only be transformed from one state to another, such as light energy becoming chemical energy in plants. In any closed system, the total amount of energy remains constant throughout these transformations. This principle is a cornerstone for analyzing energy flows and efficiency within biological and physical systems.

34. (A) Radiation
Radiation is the transfer of energy through electromagnetic waves and is the only heat transfer mechanism that can travel through the vacuum of space. The Sun's energy reaches the Earth primarily in the form of shortwave radiation. Once absorbed by the Earth's surface and atmosphere, this energy is converted into heat. This process is the fundamental driver of Earth's climate, weather patterns, and the energy cycles that support life.

35. (C) Conservation of mass
A material balance equation is a mathematical expression of the law of conservation of mass within a defined system. It accounts for the mass of a substance entering, leaving, and accumulating in the system over time. If a system is at steady state, the accumulation is zero, meaning input equals output. This principle is essential for environmental engineering and science to track pollutants and manage resource cycles in various environments.

36. (D) Hydrosphere
The hydrosphere encompasses the total mass of water found on, under, and above the surface of a planet. This includes liquid water in oceans, rivers, and lakes, frozen water in glaciers and ice caps, groundwater stored in aquifers, and water vapor in the atmosphere. The hydrosphere is dynamic, with water constantly moving between these reservoirs through the hydrological cycle, which is driven by solar energy and gravity.

37. (C) (a), (b), and (d)
The lithosphere is the Earth's outermost solid shell, comprising the crust and the brittle, uppermost portion of the mantle. It is not a static layer but is broken into several large and small tectonic plates. These plates move slowly over the more ductile asthenosphere below, leading to geological activities such as earthquakes, volcanic eruptions, and mountain formation. The lithosphere provides the physical foundation for terrestrial ecosystems and contains essential mineral resources.

38. (B) Biosphere
The biosphere represents the relatively thin layer of the Earth's surface where life exists. It integrates all living organisms and their relationships, extending from the deepest ocean trenches to the lower atmosphere. The biosphere depends on the continuous flow of energy from the sun and the cycling of nutrients from the lithosphere, hydrosphere, and atmosphere. It is the global sum of all ecosystems and represents the highest level of biological organization.

39. (D) Planning agricultural practices and research suitable for specific regions.
Agro-climatic zones are used as a framework for regional agricultural planning and research. By classifying areas according to their specific climatic and soil conditions, policymakers can develop strategies that are best suited for local environments. This includes selecting appropriate crops, determining irrigation needs, and managing land use sustainably. The goal is to optimize agricultural productivity while ensuring that farming practices are compatible with the ecological constraints and resources of each unique region.

40. (A) Both A and R are true and R is the correct explanation of A.
Remote sensing is an invaluable tool for monitoring deforestation because it allows for the systematic observation of large, often inaccessible forested areas. Satellite imagery provides a historical record of land cover, enabling scientists to compare images from different years to detect forest loss. By identifying changes in vegetation density and extent, researchers can quantify the rate of deforestation and identify specific areas under threat. This objective data is essential for conservation efforts.

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41. (C) Vector data model
The vector data model is used in Geographic Information Systems to represent discrete geographic features. It uses points to denote specific locations, lines for linear features like roads and rivers, and polygons for areas like lakes or land parcels. Each feature is defined by precise coordinates, allowing for accurate representation of boundaries and shapes. This model is particularly useful for tasks requiring high spatial precision and for storing attribute data associated with specific objects.

42. (A) The ratio of water vapor to dry air when the air is saturated.
The saturation mixing ratio is the maximum amount of water vapor that a parcel of dry air can hold at a specific temperature and pressure. It is defined as the ratio of the mass of water vapor to the mass of dry air when the air is in equilibrium with a flat surface of pure liquid water. This value increases significantly with temperature, explaining why warmer air has a higher capacity for moisture than cooler air.

43. (D) Directly converting waste into energy within the software environment.
Geographic Information Systems are used extensively in waste management for spatial tasks such as selecting landfill sites, monitoring leachate plumes, and optimizing collection routes. These applications involve analyzing geographic data to improve operational efficiency and environmental safety. However, GIS is a digital tool for analysis and mapping; it does not physically perform the chemical or mechanical processes required to convert waste into energy. Such transformations occur in specialized treatment facilities, not within software.

44. (A) (c), (a), (e), (b), (d)
The remote sensing process typically begins with an energy source, usually the sun, providing illumination. This energy interacts with the target on the Earth's surface. Sensors then acquire the reflected or emitted energy. The data is transmitted to a ground station for reception and initial processing. Finally, the processed data is analyzed to extract information, which is then presented to users. This logical flow ensures that raw signals are converted into useful geographic knowledge.

45. (C) Ecocentrism
Ecocentrism is a holistic ethical framework that assigns intrinsic value to entire ecosystems, including both living organisms and non-living components like water and soil. Unlike anthropocentrism or biocentrism, it emphasizes the importance of ecological processes and the health of the system as a whole. From an ecocentric perspective, the well-being of the entire environmental community takes precedence, and human actions are judged by their impact on the integrity and stability of ecosystems.

46. (D) Fostering skills and motivations to participate in environmental protection.
Environmental education aims to provide individuals with the knowledge, skills, and motivations necessary to protect the environment. It fosters a sense of responsibility and encourages active participation in solving environmental problems. By raising awareness of ecological issues and human impacts, education empowers people to make informed decisions and adopt sustainable lifestyles. This process is essential for building a society that values nature and works collectively toward environmental conservation and long-term sustainability.

47. (A) Outflow through a dam's spillway.
In a mass balance analysis for a lake, an output is any process by which water or a pollutant leaves the system. An example is the outflow of water through a dam's spillway or a downstream river. Other outputs can include evaporation and groundwater infiltration. In contrast, inflows from rivers, direct precipitation, and surface runoff are considered inputs. Accurately identifying these flows is crucial for calculating the accumulation or depletion of substances within the lake.

48. (B) 1013.25 millibars
Standard atmospheric pressure at sea level is a benchmark value used in meteorology and physics. It is defined as approximately 1013.25 millibars, which is equivalent to 101.325 kilopascals or one atmosphere. This pressure represents the weight of the air column above a unit area at sea level. Atmospheric pressure varies with altitude and weather conditions, but this standard value provides a consistent reference point for scientific calculations and instruments like barometers.

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49. (B) Environmental systems are complex and interconnected.
A central principle of environmental science is that environmental systems are exceptionally complex and deeply interconnected. Changes in one part of an ecosystem often lead to unforeseen consequences in other areas due to various feedback loops and dependencies. Recognizing this complexity is essential for addressing environmental challenges effectively. Solutions must consider the entire system rather than focusing on isolated parts, as human activities frequently have broad and lasting impacts on the natural world.

50. (A) The interaction between physical, biological, and cultural elements.
The scope of environmental science is broad and interdisciplinary, encompassing the study of interactions between physical, biological, and cultural elements. It examines how natural systems function and how they are affected by human activities. This includes investigating pollution, resource management, climate change, and biodiversity. By integrating knowledge from various fields, the discipline provides a holistic understanding of environmental issues and develops strategies for sustainable living and the protection of the Earth's life-support systems.

51. (A) (a), (c), and (e) only
Meteorological parameters describe the physical state of the atmosphere. Humidity measures moisture content, while wind velocity includes both speed and direction. Solar radiation is the ultimate energy driver for the Earth's climate. Contrary to some misconceptions, precipitation occurs in many forms besides rain, such as snow and hail. Additionally, atmospheric pressure actually decreases with altitude because there is less air above. Understanding these parameters is vital for weather forecasting and climate study.

52. (D) The trapping of pollutants near the ground.
A temperature inversion occurs when a layer of warm air sits above a layer of cooler air near the surface. This stable arrangement prevents the normal upward movement of air, effectively trapping pollutants and moisture at ground level. Inversions often lead to poor air quality and reduced visibility as smoke, dust, and chemicals accumulate. This condition is common in valleys during winter and can exacerbate the health impacts of urban and industrial pollution.

53. (C) Flora and fauna have a shared and distinct evolutionary history.
Biogeographic provinces are large regions characterized by distinct assemblages of plants and animals that share a common evolutionary history. These boundaries are determined by historical geological events and climatic barriers that have influenced species distribution over millions of years. Unlike political borders, these provinces reflect the natural patterns of life on Earth. Studying them helps scientists understand biodiversity patterns, species endemism, and the historical processes that have shaped current ecological communities across the globe.

54. (B) Inter-generational equity.
The core of sustainable development lies in inter-generational equity, which ensures that the actions of the current generation do not deplete resources or degrade the environment for future ones. This principle demands a balance between meeting immediate economic and social needs and preserving the planet's life-support systems for the long term. It challenges the traditional focus on short-term gain, advocating for a stewardship approach where the environment is protected for the benefit of all generations.

55. (B) P-4, Q-1, R-3, S-2
Environmental ethics categorizes different worldviews based on what they value. Anthropocentrism is human-centered, valuing nature only for human use. Biocentrism extends moral value to all living things, emphasizing that every organism has a right to exist. Ecocentrism takes a holistic view, valuing entire ecological systems including abiotic components. Sustainable development focuses on balancing environmental health with human needs across time. These frameworks guide how society perceives and addresses its responsibilities toward the natural world.

56. (A) Develop a population that is aware of and concerned about the environment.
The primary goal of environmental education is to cultivate a global population that is both aware of and concerned about the environment. It seeks to provide individuals with the knowledge,

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skills, and commitment to work toward solving current environmental problems and preventing new ones. By fostering a deeper understanding of ecological interconnected ness, education encourages people to adopt more sustainable lifestyles and participate actively in the protection and improvement of their local and global environment.

57. (C) The evaporation of water from a lake surface.
Evaporation is a classic example of mass transfer across the air-water interface. In this process, liquid water molecules gain enough energy to escape into the atmosphere as water vapor. This movement of matter from the hydrosphere to the atmosphere is a critical component of the global water cycle. Other examples of interface exchange include the absorption of carbon dioxide by oceans and the release of oxygen from aquatic plants into the air.

58. (B) Statement I is correct, but Statement II is incorrect.
The environmental lapse rate is the actual observed change in air temperature with altitude at a specific time and location. It is highly variable. In contrast, the adiabatic lapse rate describes the temperature change of a moving air parcel. While the dry adiabatic rate is relatively constant, the saturated rate varies with temperature and pressure. Therefore, suggesting that the adiabatic rate is a universal, unchanging constant is incorrect, as it depends on moisture levels.

59. (D) Conduction
Conduction is the transfer of heat through a substance without the overall movement of the substance itself. It occurs through direct molecular contact, where faster-moving particles in the hotter region transfer kinetic energy to neighboring slower-moving particles. This mechanism is most efficient in solids, especially metals like the spoon in hot tea. As the submerged end heats up, energy travels through the metal atoms until the entire handle becomes hot to the touch.

60. (B) Sunlight
A natural resource is a material or form of energy found in nature that is useful to humans. Sunlight is a primary example, providing the energy necessary for photosynthesis and a renewable source of solar power. Natural resources also include water, minerals, forests, and fertile soil. In contrast, items like plastic bags, computer software, and machinery are human-made products derived from natural resources but are not considered natural resources in their final manufactured forms.

61. (C) Active sensors
Active remote sensing systems are equipped with their own internal source of energy to illuminate the target. They emit a signal, such as a pulse of microwave or laser energy, and then measure the radiation that is reflected back to the sensor. This capability allows active sensors, like Radar or LiDAR, to operate independently of sunlight. Consequently, they can acquire data at night and often through thick cloud cover, providing unique advantages for environmental monitoring.

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62. (D) The vector data model
In Geographic Information Systems, a city map representing roads as lines, parks as polygons, and lights as points is a classic application of the vector data model. This model represents geographic features using precise coordinate geometry. Points identify specific locations, lines connect points to show linear features, and polygons define enclosed areas. This structure is ideal for representing discrete objects with clear boundaries and for storing detailed descriptive information about each feature in an associated database.

63. (A) Determining the quantity, quality, and value of the resources.
Assessing natural resources involves a systematic evaluation to determine their quantity, quality, and economic or ecological value. This process is essential for informed decision-making and sustainable management. By understanding how much of a resource exists and its current condition, planners can develop strategies for its use that ensure long-term availability. Assessments often involve field surveys, remote sensing, and statistical modeling to provide a comprehensive overview of the resource base and its potential for development.

64. (B) It is a dynamic relationship where humans modify and are affected by environment.

The relationship between humans and the environment is dynamic and reciprocal. Humans rely on natural systems for resources and services, while simultaneously modifying those systems through activities like agriculture, urbanization, and industrialization. These environmental changes, in turn, affect human health, economies, and societies. Understanding this ongoing interaction is a central theme in environmental science, as it highlights the need for sustainable practices that maintain the balance between human needs and the integrity of natural ecosystems.

65. (D) A is false but R is true.
The biosphere is not a self-contained system; it depends entirely on the atmosphere, hydrosphere, and lithosphere. While life is centralized in the biosphere, the energy and matter required for survival cycle through all Earth's spheres. For example, plants use sunlight from the atmosphere and nutrients from the soil in the lithosphere. Therefore, the biosphere is deeply integrated with other systems, and changes in one sphere inevitably impact the others through complex feedback mechanisms.

66. (A) Infrared
Thermal remote sensing primarily utilizes the infrared portion of the electromagnetic spectrum, specifically the thermal infrared region. All objects with a temperature above absolute zero emit infrared radiation. By detecting this emitted energy, thermal sensors can measure the surface temperature of the Earth, oceans, and atmosphere. This technology is widely used for monitoring heat islands in cities, tracking volcanic activity, managing irrigation in agriculture, and studying the Earth's energy balance and climate change.

67. (C) Glaciers and ice caps
The hydrosphere includes all water found on Earth. A significant and vital component is the cryosphere, which consists of water in its frozen form, such as glaciers, ice sheets, and permafrost. These ice masses store the majority of the planet's fresh water and play a crucial role in regulating global climate and sea levels. While the ozone layer belongs to the atmosphere and tectonic plates to the lithosphere, glaciers are fundamentally part of the hydrosphere's total water budget.

68. (D) Input - Output = Accumulation
The basic material balance equation follows the principle of mass conservation, stating that the mass entering a system minus the mass leaving must equal the mass accumulated within the system. Mathematically, this is expressed as Input minus Output equals Accumulation. If the system is at steady state, accumulation is zero, meaning inputs and outputs are perfectly balanced. This equation is the fundamental tool for tracking pollutants and resources in environmental science and engineering.

69. (D) (a), (b), (c), and (d)
Remote sensing and GIS have diverse applications in environmental management. They are used to monitor urban sprawl by tracking land-use changes over time and to identify areas at risk of desertification by analyzing vegetation and soil data. In forestry, these tools assist in inventory mapping and fire risk assessment. They also enable scientists to measure changes in glacial ice cover, providing critical evidence for climate change studies. These integrated technologies are essential for comprehensive environmental monitoring.

70. (B) Air becomes saturated and condensation begins to form.
The dew point is the specific temperature at which a given parcel of air must be cooled, at constant pressure, to become fully saturated with water vapor. At this temperature, the air's relative humidity reaches one hundred percent, and any further cooling will lead to the condensation of moisture into liquid water droplets. This process results in the formation of dew, fog, or clouds. The dew point is a reliable measure of the actual moisture content in the air.

71. (D) Environmental Ethics
Environmental ethics is the branch of environmental science and philosophy that explores the moral relationship between human beings and the natural world. It addresses the ethical implications of human actions, such as resource consumption and pollution, and asks whether non-human entities like animals and ecosystems have intrinsic rights. This field provides the moral framework necessary for making value-based decisions about environmental protection and sustainable

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development, moving beyond purely technical or economic considerations of nature.

72. (A) A grid of cells, or pixels, with each cell containing a value.
Raster data in Geographic Information Systems represents geographic features as a continuous grid of square cells, or pixels. Each cell contains a specific value representing information such as elevation, temperature, or land cover type. This data model is particularly effective for capturing phenomena that vary continuously across space, such as satellite imagery or digital elevation models. The resolution of a raster dataset is determined by the size of the individual cells, with smaller cells providing more detail.

73. (C) Climatic and soil conditions
The primary reason for the diverse agro-climatic zones in India is the significant variation in climatic and soil conditions across the country. Factors such as temperature ranges, annual rainfall patterns, and the physical and chemical properties of the soil vary greatly from the Himalayas to the coastal plains. These variations determine the types of crops that can be successfully grown and the farming practices required, necessitating a regionalized approach to agricultural planning and resource management.

74. (A) GIS
The principle that near things are more related than distant things is known as Tobler's First Law of Geography. This concept is fundamental to spatial analysis and is operationalized by Geographic Information Systems. GIS uses this relationship to interpolate data, identify clusters, and analyze how environmental factors interact over space. By accounting for the geographical proximity of features, GIS allows scientists to model real-world processes more accurately and understand the spatial structure of environmental phenomena.

75. (A) (d), (b), (a), (c)
The history of environmental awareness follows a distinct chronological path. It began with the rise of industrial-era pollution, which sparked early concerns. The 1972 Stockholm Conference was the first major international meeting on the human environment. This was followed by the 1987 Brundtland Commission report, which defined sustainable development. Finally, the 1992 Rio Earth Summit (UN Conference on Environment and Development) solidified these concepts into global action plans. This sequence reflects society's evolving response to ecological crises.

76. (B) Law of Conservation of Mass
The concept of material balance is a direct application of the law of conservation of mass. This physical law states that in any closed system, mass can neither be created nor destroyed by chemical reactions or physical transformations. Consequently, every atom of a pollutant or resource entering an environmental system must either be stored within it or exit through its boundaries. This principle allows environmental scientists to create accurate budgets for water, carbon, and other substances.

77. (C) Environmental Science
Studying the impact of a dam on fish migration falls squarely within the scope of environmental science. This task requires an interdisciplinary approach, combining knowledge of hydrology, ecology, and engineering. It examines how human-made structures modify natural habitats and affect the biological life cycles of aquatic species. Environmental science is uniquely equipped to analyze these complex interactions between the physical environment and living organisms, providing the scientific basis for mitigating negative impacts on biodiversity.

78. (D) Stratosphere
The ozone layer is primarily located in the stratosphere, approximately fifteen to thirty-five kilometers above the Earth's surface. This good ozone is essential for life because it absorbs most of the Sun's harmful ultraviolet (UV) radiation. Without this protective shield, high levels of UV radiation would reach the surface, causing significant damage to living tissues and ecosystems. In contrast, ozone found in the troposphere is considered a pollutant and a major component of photochemical smog.

79. (A) P-3, Q-2, R-1, S-2
Different processes demonstrate various heat transfer mechanisms. The Sun warming the Earth is a result of radiation, which travels through space. Heat moving through a solid

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iron rod occurs via conduction, where energy passes through direct molecular contact. The circulation of water in a pot and the formation of land and sea breezes are examples of convection, which involves the physical movement of fluids. These mechanisms work together to redistribute thermal energy across the Earth's surface and atmosphere.

80. (B) The tendency of a lifted air parcel to return to its original position.
A stable atmosphere is defined by a condition where a vertically displaced air parcel tends to return to its original position. This occurs because the parcel becomes denser and cooler than the surrounding air as it rises, or warmer and less dense as it sinks. Stability inhibits vertical air movement and the development of large clouds. Such conditions often lead to clear skies or thin, layered clouds and can cause pollutants to accumulate near the ground.

81. (B) The wind blows most frequently from the southwest.
A wind rose uses spokes to represent different cardinal directions, and the length of each spoke indicates the frequency of wind from that direction. If a wind rose has very long bars extending toward the southwest, it signifies that the wind blows most frequently from that direction. This information is vital for many environmental applications, such as predicting the path of air pollution from a factory or determining the optimal orientation for wind turbines to maximize energy capture.

82. (A) Caused or influenced by human beings.
The term anthropogenic refers to any environmental change or process that is caused or influenced by human activity. This includes pollution, land-use changes like deforestation and urbanization, and the emission of greenhouse gases. Distinguishing between natural and anthropogenic factors is a key task in environmental science, as it helps identify the human role in global challenges like climate change and biodiversity loss, which is essential for developing effective mitigation and management strategies.

83. (B) (c) and (d) only
Sustainable development is built on the integration of environmental health, social equity, and economic prosperity. It is a holistic approach that recognizes the finite nature of resources and the necessity of planning for both present and future generations. The concept was popularized by the Brundtland Report, rather than the Kyoto Protocol. By balancing these three dimensions, sustainable development seeks to ensure that human progress does not come at the expense of the planet's long-term ecological stability.

84. (D) Sustainable management and planning.
The assessment of natural resources is a fundamental requirement for sustainable management and planning. By systematically evaluating the quantity, quality, and distribution of resources like water, minerals, and forests, society can make informed decisions about their use. This process identifies areas that need protection and determines the limits of resource extraction. Without accurate assessments, it is impossible to develop long-term strategies that balance economic needs with the maintenance of healthy ecosystems and resource availability.

85. (C) Categorizing pixels in an image into land cover classes.
Digital image classification is a technique in remote sensing where computer algorithms are used to automatically categorize the pixels in an image into specific land cover classes. This process relies on the spectral signatures of different objects, such as forests, water bodies, or urban areas. By assigning each pixel to a category, scientists can generate maps that quantify the extent and distribution of various features on the Earth's surface, providing essential data for environmental monitoring and planning.

86. (A) Both Statement I and Statement II are correct.
Remote sensing systems are classified as either passive or active. Passive systems, such as optical cameras on satellites, depend on external energy, primarily sunlight, to illuminate the Earth's surface. Consequently, they can only acquire data during the day. Active systems, like Radar, provide their own energy source by emitting signals toward the target. This independence allows active sensors to operate effectively at night and often through clouds, making them

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highly versatile for continuous environmental observation and mapping.

87. (D) A television documentary about wildlife conservation.
Non-formal environmental education refers to organized learning activities that occur outside of the structured, traditional school and university system. A television documentary about wildlife conservation is a prime example, as it aims to inform and engage the public in an accessible way. While formal education leading to degrees is structured and hierarchical, non-formal education is more flexible and often targets a broader audience to raise general awareness and encourage responsible environmental behavior throughout the community.

88. (A) Preserving a wilderness area in its natural state, even if it means forgoing economic benefits.
An ecocentric worldview prioritizes the health and integrity of the entire ecosystem over specific human interests. This perspective would support preserving a wilderness area in its natural state purely for its intrinsic value, even if this means forgoing potential economic gains from resource extraction or development. Unlike anthropocentrism, which values nature for its utility, ecocentrism recognizes that all components of an ecosystem have a right to exist and function together as a stable, interconnected whole.

89. (C) 20 units/day
In a mass balance study, the accumulation of a substance is calculated by subtracting the total output from the total input. For a lake receiving one hundred units of water per day and losing eighty units per day, the accumulation is twenty units per day. This positive value indicates that the volume of water in the lake is increasing. Understanding these balances is essential for managing water levels and predicting how the concentration of pollutants will change over time.

90. (A) That human activities are now a major force of change.
While geological processes have shaped the Earth over millions of years, environmental science emphasizes that human activities have now become a major force of global change. This concept is often described as the Anthropocene, where the scale of human impact on the atmosphere, biosphere, and lithosphere rivals natural geological forces. Recognizing this role is crucial for understanding current environmental crises and highlights the need for interdisciplinary solutions that address the human-driven nature of these changes.

91. (D) Argon - 0.93%
The Earth's atmosphere consists of a specific mixture of gases, each with a characteristic concentration. Nitrogen is the most abundant at approximately seventy-eight percent, followed by oxygen at twenty-one percent. Argon is the third most common gas, making up about 0.93 percent by volume. Carbon dioxide, while critically important for the climate, exists only as a trace gas at much lower concentrations. These proportions are remarkably consistent throughout the lower layers of the atmosphere.

92. (B) Glaciers and ice sheets
Although water covers most of the Earth's surface, only a small fraction is fresh water. The majority of this fresh water is not found in rivers or lakes but is locked away in glaciers and polar ice sheets. Groundwater represents the second-largest reservoir of fresh water. Rivers and lakes, which are the most accessible sources for human use, actually contain a very small percentage of the planet's total fresh water supply, highlighting the need for careful management.

93. (C) Lithosphere
The lithosphere is the rigid, outermost layer of the Earth. It is composed of the entire crust, which can be either oceanic or continental, and the brittle upper portion of the mantle. This layer floats on top of the semi-plastic asthenosphere. The lithosphere is broken into tectonic plates that interact at their boundaries, causing major geological events. It provides the physical substrate for all terrestrial life and is the source of essential mineral and soil resources.

94. (A) Both A and R are true and R is the correct explanation of A.
A temperature inversion occurs when a layer of warm air sits above cooler air near the surface, reversing the normal temperature gradient. This warm layer acts like a physical lid, preventing

the vertical dispersion of air and trapping pollutants at ground level. In such conditions, the concentration of smoke, exhaust, and industrial emissions can rise dramatically, leading to severe smog and health risks. Inversions are particularly problematic in urban areas surrounded by complex terrain like mountains.

95. (A) The smallest single element of a digital image.
In remote sensing and digital imaging, a pixel is the smallest individual unit of information in a digital image. The word is derived from picture element. Each pixel corresponds to a specific area on the Earth's surface and contains a value that represents the intensity of radiation reflected or emitted from that area. The size of the pixel determines the spatial resolution of the image, with smaller pixels providing more detail and higher clarity for analysis.

96. (B) The classification of remotely sensed data.
Ground truthing is the essential practice of verifying the results of remote sensing analysis by making direct observations on the ground. By comparing the digital classification of land cover with real-world conditions, scientists can assess the accuracy of their maps and refine their analysis. This process ensures that the information extracted from satellite imagery is reliable and provides a true representation of the landscape, which is critical for scientific research and informed land management decisions.

97. (B) Mapping forest fire risk zones based on fuel type, slope, and weather data.
Geographic Information Systems are widely used in forestry for complex tasks like mapping forest fire risk. By overlaying data on vegetation types (fuel), terrain slope, and local weather conditions, planners can identify areas most vulnerable to fire. GIS also assists in managing timber harvesting, tracking reforestation efforts, and monitoring the impact of pests or diseases. These spatial tools allow foresters to analyze entire landscapes and develop sustainable management plans that balance economic and conservation goals.

98. (A) Students will be able to analyze a local environmental issue and propose a viable solution.
A competency-based objective in environmental education focuses on the practical application of knowledge and skills. An example is requiring students to analyze a local environmental issue and propose a viable solution. This approach goes beyond simple rote memorization of facts, encouraging students to think critically and act responsibly. By engaging with real-world problems, students develop the analytical and problem-solving abilities necessary to address environmental challenges in their own communities and contribute to broader sustainability goals.

99. (C) Shared resources are inevitably overexploited and degraded by individuals acting in their own self-interest.
The tragedy of the commons describes a situation where individual users, acting independently and rationally according to their own self-interest, deplete or spoil a shared resource even though it is not in anyone's long-term interest. Examples include overgrazing of public pastures or overfishing in international waters. This concept highlights the challenges of managing resources that are freely available to all and emphasizes the need for collective action, regulation, and sustainable management practices.

100. (A) P-4, Q-1, R-2, S-3
Various environmental concepts are associated with specific scientific fields. A wind rose is a standard tool in meteorology used to display wind patterns. Vector data is a fundamental data model used in Geographic Information Systems for representing discrete geographic features. The Second Law of Thermodynamics is a core principle in the study of energy systems. Biocentrism is a specific viewpoint within environmental ethics that grants moral standing to all living beings, reflecting the interdisciplinary nature of environmental science.

101. (A) (a), (d), (b), (c)
Biogeographic realms are large regions of the Earth's surface where organisms have evolved in relative isolation. The Palearctic realm, covering most of Eurasia and North Africa, is the largest. It is followed by the Afrotropical realm (Sub-Saharan Africa), the Nearctic realm (North America), and the Neotropical realm (South and Central America). This order, from the Palearctic

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down to the Neotropical, reflects the approximate land area of these vast regions, which is a key factor in biodiversity patterns.

102. (B) What is the moral relationship between humans and the non-human world?
Environmental ethics primarily investigates the moral relationship between human beings and the non-human world. It goes beyond technical questions about pollution levels to ask what duties and responsibilities we have toward animals, plants, and entire ecosystems. This field explores whether the environment has intrinsic value or exists solely for human use. By addressing these fundamental questions, environmental ethics provides the values and reasoning that underpin conservation policies and sustainable practices across the globe.

103. (D) Electromagnetic radiation
The fundamental principle of remote sensing is the interaction between electromagnetic radiation and objects on the Earth's surface. Sensors detect energy that is either reflected from the sun or emitted as heat by the objects themselves. Different materials reflect and absorb radiation differently across various wavelengths, creating unique spectral signatures. By analyzing these signatures, scientists can identify and map different types of land cover and environmental conditions from a distance, without needing direct physical contact.

104. (B) (b), (c), and (d)
Environmental Science is a broad, interdisciplinary field that addresses complex systems with many interacting components. Its scope encompasses major global issues such as climate change, biodiversity loss, and pollution. A central and guiding theme of the discipline is the principle of sustainability, which seeks to balance human needs with ecological health. Unlike narrow, monodisciplinary sciences, it integrates knowledge from diverse fields to provide a holistic understanding of the environment and develop effective solutions for long-term survival.

105. (C) ELR is the actual temperature profile of the ambient air, while ALR is the rate of temperature change in a moving air parcel.
The environmental lapse rate (ELR) and the adiabatic lapse rate (ALR) represent two different ways temperature changes with altitude. The ELR is the actual observed temperature profile of the static, ambient air at a specific location. In contrast, the ALR refers to the rate at which the temperature of a moving parcel of air changes as it rises or sinks. Comparing these two rates is the fundamental method used by meteorologists to determine atmospheric stability.

106. (A) Spatial analysis
Spatial analysis is the core function of a Geographic Information System, allowing users to integrate and analyze different types of geographic data to uncover new information. An example is overlaying maps of soil types, slope, and rainfall to identify areas at high risk for erosion. By combining these diverse spatial datasets based on their common location, GIS can model complex environmental processes and provide valuable insights for land use planning, resource management, and disaster prevention.

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107. (B) Statement I is incorrect, but Statement II is correct.
The laws of thermodynamics govern the flow of energy through ecosystems. The First Law states that energy is conserved and not destroyed, contradicting any claim of its disappearance. The Second Law explains that with every energy transfer, some energy is inevitably lost as low-quality heat. This results in a significant reduction in available energy at successively higher trophic levels, which is why food chains typically have a pyramidal structure with fewer organisms at the top.

108. (B) Time scale of the phenomena.
The fundamental distinction between weather and climate lies in the time scale over which atmospheric phenomena are observed. Weather refers to the short-term state of the atmosphere at a specific time and place, including daily temperature and precipitation. Climate is the statistical summary of weather conditions over a much longer period, typically thirty years or more. While weather tells us what to wear today, climate helps us understand the long-term environmental patterns of a particular region.

109. (C) Soil pH
Meteorological parameters are physical properties used to describe the state of the atmosphere and

predict weather. These include humidity, which measures moisture; wind velocity, describing air movement; and air pressure, indicating the weight of the air column. Soil pH, while an important environmental factor, is a chemical property of the lithosphere rather than an atmospheric parameter. Understanding the distinction between these parameters is essential for specialized studies in meteorology, hydrology, and soil science.

110. (B) Structure of the lithosphere
The lithosphere is not a continuous shell but is divided into several large and small tectonic plates. The study of how these plates move and interact—such as colliding, pulling apart, or sliding past each other—is fundamental to understanding the Earth's structure and geological history. These interactions are responsible for the formation of mountains, ocean basins, and major events like earthquakes and volcanoes. This dynamic nature of the lithosphere significantly influences the planet's surface and biosphere.

111. (A) (a), (b) and (d)
GIS and remote sensing are versatile tools for environmental and societal management. GIS is used for logistics, such as planning emergency vehicle routes, while remote sensing is critical for monitoring crop health and mapping land use/land cover (LULC). These technologies are highly effective for studying climate change by tracking changes in ice cover and sea levels. Furthermore, ground truthing is a necessary process that increases the reliability of remote sensing analysis by providing real-world verification of digital results.

112. (B) Cryosphere
The cryosphere is the specialized term for the portion of the Earth's surface where water is in a solid, frozen state. This includes vast ice sheets in Antarctica and Greenland, mountain glaciers, sea ice, snow cover, and permafrost. As a sub-component of the hydrosphere, the cryosphere plays a vital role in the Earth's climate system by reflecting solar radiation and storing the majority of the world's fresh water, making its study critical for understanding global warming.

113. (B) Stable
An atmosphere is considered stable when a vertically displaced air parcel tends to return to its original level. This occurs if a rising parcel cools adiabatically and becomes cooler and denser than the surrounding ambient air. Because the parcel is heavier than its environment, it lacks buoyancy and sinks back down. This resistance to vertical motion limits cloud development and the mixing of air, often leading to clear weather and the trapping of ground-level pollutants.

114. (A) Sustainable Development
The 1987 Brundtland Commission report, officially titled Our Common Future, is most famous for introducing the widely accepted definition of sustainable development. It defined the term as development that meet the needs of the present without compromising the ability of future generations to meet their own needs. This landmark document emphasized the interdependence of economic growth, social equity, and environmental protection, setting the stage for global efforts to achieve long-term planetary health and human well-being.

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115. (C) Solar energy
A renewable natural resource is one that is replenished naturally over relatively short periods, making it essentially inexhaustible for human use. Solar energy is a primary example, as it is constantly provided by the sun. Other examples include wind, tidal, and geothermal energy. In contrast, fossil fuels like coal, petroleum, and natural gas are non-renewable because they take millions of years to form and are being consumed much faster than they can be replaced by nature.

116. (A) Both A and R are true and R is the correct explanation of A.
A key principle in environmental science is that everything must go somewhere, reflecting the law of conservation of mass. This physical law states that matter is neither created nor destroyed. Consequently, when pollutants are released into the environment, they do not disappear; they are either accumulated, transformed, or transported elsewhere. This principle is the foundation of the material balance concept, which allows scientists to track the movement and fate of substances through air, water, and soil systems.

117. (C) Reduces rainwater infiltration into soil, increasing surface runoff volumes.
Urbanization often involves replacing natural ground with impervious surfaces like concrete and asphalt. These materials prevent rainwater from infiltrating the soil, which significantly increases the volume and speed of surface runoff. Instead of being absorbed by the ground and recharging groundwater, water flows rapidly into drainage systems and local water bodies. This process is a primary cause of increased flash flooding in urban areas, as the environment's natural capacity to manage rainfall is drastically reduced.

118. (B) It functions independently of solar energy.
The biosphere is the global sum of all ecosystems and represents the zone of life on Earth. Contrary to the idea of independence, the biosphere is fundamentally dependent on solar energy to drive photosynthesis, which is the foundation of most food chains. Solar energy also regulates the Earth's climate and the water cycle, both of which are essential for supporting life. Without the continuous input of energy from the sun, the complex biological processes within the biosphere would cease to function.

119. (D) Conduction
Conduction is the specific mechanism of heat transfer that occurs through direct physical contact between objects or within a material. It involves the transfer of kinetic energy between neighboring atoms or molecules. Faster-moving particles in the warmer region collide with and transfer energy to slower-moving particles in the cooler region. This process is most effective in solids, where molecules are closely packed, and it plays a vital role in heating the air immediately adjacent to the Earth's surface.

120. (A) Burning of fossil fuels
The burning of fossil fuels is the most significant anthropogenic source of environmental change in the modern era. This activity releases vast amounts of carbon dioxide and other greenhouse gases into the atmosphere, which is the primary driver of current global warming and climate change. Unlike natural processes such as volcanic eruptions or solar cycles, the scale and speed of human-driven emissions are unprecedented and have profound impacts on the Earth's energy balance, ecosystems, and human societies.

121. (C) 15
The Planning Commission of India has classified the country into fifteen major agro-climatic zones. This classification is based on regional variations in geography, climate, and soil characteristics. By dividing the nation into these zones, the government can develop targeted agricultural strategies that are best suited to the specific environmental conditions of each region. This approach is essential for optimizing agricultural productivity, managing natural resources sustainably, and addressing the unique challenges faced by farmers in different parts of India.

122. (A) Spectral band
In remote sensing, a spectral band refers to a specific, continuous range of wavelengths in the electromagnetic spectrum that a sensor is designed to detect. Satellites often have multiple sensors, each capturing data in a different band, such as visible red, near-infrared, or thermal infrared. Different objects on the Earth's surface reflect and emit radiation differently across these bands. By analyzing data from multiple bands, scientists can identify land cover types and monitor environmental conditions with high precision.

123. (D) Anthropocentrism
Anthropocentrism is an ethical framework that considers human beings as the sole or central possessors of moral standing. In this view, only humans and their interests have intrinsic value, and the natural world is valued only for its usefulness to humanity. This perspective often leads to a focus on resource exploitation and economic growth above the protection of nature for its own sake. It contrasts with biocentric and ecocentric theories that extend moral consideration to non-human life and ecosystems.

124. (A) P-3, Q-2, R-1, S-4
The atmosphere is divided into layers with distinct features. The troposphere is the lowest layer where most weather events occur. The stratosphere contains the ozone layer, which protects life from UV radiation. In the mesosphere, the atmosphere is thin enough that meteors typically burn up. The

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thermosphere is characterized by extremely high temperatures and phenomena like the Aurora Borealis. This vertical structure is fundamental to understanding atmospheric science and how the Earth interacts with solar radiation and space.

125. (C) Inform the public and influence their behaviors toward the environment.
The primary goal of environmental awareness campaigns is to inform the public about ecological issues and influence their attitudes and behaviors toward the environment. By providing information on topics like pollution, resource depletion, and climate change, these campaigns seek to foster a sense of responsibility and encourage individuals to adopt more sustainable practices. This public engagement is a critical component of environmental protection, as informed citizens are more likely to support conservation efforts and demand effective environmental policies.

126. (D) Ground truthing
Ground truthing is the essential process of visiting specific locations in person to verify the information derived from satellite imagery or aerial photographs. By comparing the digital classification of land cover—such as identifying a pine forest on a map—with the actual conditions on the ground, scientists can assess the accuracy of their remote sensing analysis. This verification step is crucial for ensuring that the resulting data is reliable and provides an accurate representation of the environment for research and planning.

127. (A) Unstable
An unstable atmosphere is characterized by a condition where a parcel of air, if given an initial upward push, will continue to rise on its own. This happens because the rising parcel remains warmer and less dense than the surrounding environment at all altitudes. The resulting buoyancy drives vertical air movement, which promotes the development of clouds and allows for the effective mixing and dispersal of pollutants. Unstable conditions are often associated with active weather and good vertical visibility.

128. (A) (a) and (d) only
The atmosphere is primarily composed of nitrogen (78%) and oxygen (21%). Argon is the next most abundant gas at about 0.93%, making it more common than carbon dioxide. Contrary to some misconceptions, water vapor concentrations vary greatly across space and time, and most ozone is concentrated in the stratosphere rather than the troposphere. Understanding these proportions and the distribution of gases is fundamental to studying the Earth's energy balance, air quality, and the various chemical processes occurring in the atmosphere.

129. (B) Track the flow of materials and energy through a system.
In environmental science, the concept of material balance is used to systematically track the flow and fate of materials and energy through a defined system. By accounting for all inputs, outputs, and internal changes, scientists can determine whether a substance is accumulating or being depleted within a lake, city, or the entire planet. This tool is essential for managing natural resources, predicting the impact of pollutants, and understanding complex environmental cycles like the carbon and hydrological cycles.

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130. (A) Economic, Social, and Environmental
Sustainable development is built upon the integration and balance of three core pillars: economic viability, social equity, and environmental protection. This holistic approach recognizes that long-term human well-being and planetary health are interdependent. For development to be truly sustainable, it must promote economic prosperity while ensuring fair treatment and opportunities for all people and protecting the natural ecosystems upon which all life and economic activities ultimately depend. These pillars provide the framework for global sustainability goals and policies.

131. (C) Biogeographic provinces.
A biome is a large-scale ecological community characterized by specific vegetation and wildlife adapted to a particular climate. The concept is closely related to biogeographic provinces, which are regions defined by the shared evolutionary history of their plants and animals. While biomes focus on environmental adaptations and functional similarities across different continents, biogeographic provinces emphasize the unique species compositions resulting from geological isolation. Both concepts are essential

for understanding the global distribution of biodiversity and the complex patterns of life on Earth.

132. (D) Increased greenhouse gas emissions leading to global warming.
A fundamental goal of environmental science is to identify cause-and-effect relationships within complex systems. A clear example is the link between increased greenhouse gas emissions from human activities and the observed trend of global warming. By understanding these relationships, scientists can predict the environmental consequences of human actions and develop effective strategies to mitigate negative impacts. This scientific approach is essential for moving from mere observation of environmental changes to the development of evidence-based policies and sustainable management practices.

133. (C) 10°C per km
The dry adiabatic lapse rate (DALR) is the rate at which the temperature of an unsaturated parcel of air changes as it moves vertically through the atmosphere. For a rising parcel, this rate is approximately 10°C per kilometer of altitude. This cooling occurs because the air expands as it moves into regions of lower pressure, using internal energy to do work. The DALR is a constant value and is a primary factor used by meteorologists to analyze atmospheric stability and predict air movement.

134. (D) Statement I is incorrect, but Statement II is correct.
Geographic Information Systems are much more than tools for creating maps; their primary strength lies in their advanced analytical capabilities. A key feature of GIS is the ability to perform spatial analysis by integrating diverse datasets—such as environmental, social, and economic data—based on their geographic location. This allows users to uncover patterns, relationships, and trends that are not apparent in traditional spreadsheets. Consequently, GIS is an essential tool for informed decision-making in land use planning, resource management, and conservation.

135. (D) Biocentrism
Biocentrism is an ethical perspective that grants moral standing and consideration to all living things. It argues that every organism has intrinsic value and a right to exist, regardless of its usefulness to human beings. This worldview shifts the moral focus away from humans alone, advocating for a broader community of life where all biological entities are respected. Biocentrism is a key concept in environmental ethics, providing a framework for debates about animal rights, biodiversity conservation, and the human responsibility toward nature.

136. (A) (b), (c), (a), (d)
The vast majority of the Earth's water is stored in the oceans, which hold about 97% of the total volume. Among the sources of fresh water, glaciers and ice caps represent the largest reservoir, followed by groundwater. Surface water in lakes and rivers, although the most accessible for human use, accounts for only a very small fraction of the hydrosphere's total volume. Understanding this distribution is critical for managing global water resources and assessing the impacts of climate change on water availability.

137. (C) To promote a single, prescribed political ideology.
The primary goals of environmental education are to raise awareness, develop problem-solving skills, and encourage active participation in environmental protection. It seeks to empower individuals to make informed decisions based on scientific understanding and ethical considerations. Promoting a single, prescribed political ideology is not a goal; instead, environmental education aims to provide a broad foundation of knowledge and critical thinking skills that allow individuals to evaluate environmental issues from multiple perspectives and develop their own responsible viewpoints.

138. (A) The anthropogenic contribution to climate change.
A significant and defining modern interaction between humans and the environment is the anthropogenic contribution to climate change. Through the burning of fossil fuels and large-scale land-use changes, human activities have altered the chemical composition of the atmosphere, leading to global warming. This interaction highlights the unprecedented scale of human influence on the planet's systems

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and is a central focus of environmental science. Understanding this dynamic is essential for developing global strategies to mitigate climate impacts and transition to more sustainable ways of living.

139. (A) Both A and R are true and R is the correct explanation of A.
GIS is an exceptionally powerful tool for land use planning because it can integrate and analyze diverse spatial datasets. Planners can overlay information on zoning regulations, soil types, terrain slope, and existing infrastructure to identify the most suitable locations for new development or conservation. This capability allows for more informed and evidence-based decision-making, helping to ensure that land use plans are sustainable, efficient, and minimize environmental impacts. The spatial insights provided by GIS are essential for managing the complex needs of growing human populations.

140. (B) Urban sprawling
Urban sprawl refers to the rapid and often uncontrolled expansion of cities into surrounding rural and agricultural areas. Remote sensing is a key tool for analyzing this phenomenon, as it allows scientists to map and quantify land-use changes over large areas. By comparing satellite images from different time periods, researchers can track the conversion of natural and agricultural land into urban development. This analysis provides critical data for urban planners to manage growth more sustainably and protect valuable open spaces and agricultural resources.

141. (C) Source of Energy -> Target -> Sensor
The basic sequence of events in remote sensing begins with a source of energy, such as the sun, providing electromagnetic radiation. This energy travels through the atmosphere and interacts with the target on the Earth's surface. The radiation that is reflected or emitted by the target is then detected and recorded by a sensor on a satellite or aircraft. This recorded data is later processed and analyzed to extract information about the target, forming the foundation of modern geographic observation and mapping.

142. (A) (a), (b), (c) and (e) only
The laws of thermodynamics are fundamental principles governing energy. The First Law focuses on the quantity of energy, stating it is conserved and cannot be created or destroyed. The Second Law addresses energy quality, stating that the entropy of an isolated system increases and that energy transfers are never perfectly efficient. Consequently, a perpetual motion machine of the first kind—which creates energy—is impossible. Understanding these laws is essential for analyzing the efficiency and sustainability of energy flows in both natural and human systems.

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143. (A) Sunlight
In an ecosystem, abiotic components are the non-living physical and chemical factors that influence living organisms. Sunlight is a primary example, as it provides the energy for photosynthesis and regulates temperature. Other abiotic factors include water, soil minerals, air, and climate. In contrast, biotic components consist of all living beings, such as trees, fungi, and bacteria. The interaction between these biotic and abiotic elements defines the structure and function of an ecosystem, determining which species can survive and thrive in a particular environment.

144. (B) Economically and technologically feasible to extract.
In resource management, a resource is the total quantity of a material that is known or suspected to exist. A reserve is the specific portion of that resource that has been identified and can be legally and economically extracted using currently available technology. This distinction is critical for economic planning and sustainable management, as the size of a reserve can change based on fluctuating market prices, technological advancements, and new discoveries, even if the total resource base remains the same.

145. (B) Barometer
A barometer is a scientific instrument used specifically to measure atmospheric pressure. This pressure represents the weight of the air column above a given point and is a key indicator of changing weather patterns. Rising pressure often signals clearing skies and stable conditions, while falling pressure typically indicates approaching storms or unsettled weather. Barometers are essential tools for meteorologists in weather forecasting and are also used in various

scientific applications to account for atmospheric variations in experiments and field studies.

146. (A) Ecocentrism
Among environmental ethical frameworks, ecocentrism is the most comprehensive and holistic. It assigns intrinsic value to entire ecosystems, including all their biotic and abiotic components and the processes that link them. While anthropocentrism focuses on human needs and biocentrism on individual living beings, ecocentrism recognizes that the health and integrity of the whole system are paramount. This perspective provides a broad moral foundation for conservation, emphasizing the preservation of the Earth's life-support systems for the benefit of all their parts.

147. (C) The frequency of wind directions and speeds.
A wind rose is a specialized meteorological tool used to summarize the wind characteristics of a specific location. It provides a graphical representation of the frequency and speed of winds blowing from different directions over a defined period. By analyzing a wind rose, scientists and engineers can identify the dominant wind patterns, which is essential for tasks such as designing wind farms, siting industrial plants to minimize air pollution impacts, and understanding local climate variations driven by air movement.

148. (A) P-4, Q-2, R-1, S-3
Various terms are central to Geographic Information Systems (GIS) and Remote Sensing (RS). Vector data represents geographic features as points, lines, and polygons. Raster data uses a grid of pixels to capture continuous information. Ground truthing is the critical process of verifying digital data through direct field observations. Digital Image Processing involves the use of computer algorithms to enhance and analyze satellite imagery. Together, these concepts form the foundation for modern spatial analysis and environmental monitoring using digital technology.

149. (C) Natural sciences, social sciences, and humanities.
Environmental Science is fundamentally interdisciplinary because environmental issues are complex and multifaceted. To understand and address challenges like climate change or resource depletion, the discipline must integrate knowledge from the natural sciences (biology, chemistry, physics, geology), social sciences (sociology, economics, political science), and humanities (ethics, philosophy). This broad approach allows scientists to examine not only the physical and biological aspects of environmental problems but also the human behaviors, societal structures, and ethical values that drive and are affected by them.

150. (B) Neutral
An atmosphere is considered neutral when a vertically displaced air parcel has exactly the same temperature as its surroundings at all altitudes. In this state, the air parcel has no buoyancy and will neither continue to rise on its own nor return to its original level; it will remain at whichever height it is moved to. Neutral stability typically occurs under overcast conditions or with strong winds that promote mechanical mixing, and it represents a balance between stable and unstable atmospheric states.

151. (D) A field covering all environment and human interactions.
The scope of environmental science is comprehensive, covering all aspects of the environment and its complex interactions with human society. It is not limited to a single species or pollutant but examines the entire Earth system, including the atmosphere, hydrosphere, lithosphere, and biosphere. By investigating how natural systems function and the impacts of human activities, the discipline provides the knowledge necessary for managing resources sustainably and addressing global challenges, making it a critical field for ensuring the planet's future.

152. (A) The amount of substance in the system is decreasing.
In the material balance equation, accumulation is the difference between total input and total output. If the accumulation term is negative, it indicates that the amount of the substance within the defined system is decreasing over time. This happens when the total output—such as through removal, decay, or transformation—exceeds the total amount entering the system. Monitoring accumulation is essential for understanding

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whether a pollutant is building up in a lake or if a natural resource is being depleted.

153. (A) (a) and (b) only
The atmosphere's layers have distinct characteristics that are important for science and society. The troposphere is the densest layer and the site of most weather activity. Above it, the stratosphere is characterized by stability and the ozone layer; its lack of turbulence makes it the preferred region for commercial jet travel. Contrary to some myths, the mesosphere—not the thermosphere—is the coldest layer. These vertical variations are essential for understanding atmospheric chemistry, global climate, and the behavior of human-made flight and satellite systems.

154. (A) Convection
Convection is the primary heat transfer process responsible for the formation of land and sea breezes. During the day, land heats up faster than water, causing the air above it to rise and create a low-pressure area; cooler air from the sea then moves in to fill the gap, creating a sea breeze. At night, the process reverses as land cools faster. This vertical and horizontal movement of air, driven by temperature differences, is a classic example of convection in the environment.

155. (D) It is divided into tectonic plates.
A key feature of the lithosphere is that it is not a single, solid piece but is divided into several large and small tectonic plates. These plates are in constant, slow motion, floating on the more fluid asthenosphere below. The interactions at the boundaries of these plates—where they move toward, away from, or past each other—are the primary cause of major geological phenomena, including mountain building, volcanic activity, and earthquakes, shaping the physical foundation of the planet's ecosystems.

156. (B) Ecocentrism
The argument for preserving old-growth forests based on their intrinsic value as complex ecosystems is a clear application of ecocentrism. This ethical viewpoint holds that the environment and its systems have value in and of themselves, independent of any practical use or benefit to human beings. By focusing on the health and integrity of the forest as a whole, ecocentrism prioritizes the maintenance of natural processes and biodiversity over human-centered economic or recreational considerations, advocating for the protection of nature for its own sake.

157. (B) Both statements are true and form the definition of sustainable development.
Sustainable development is fundamentally defined by the balance between two key requirements: meeting the needs of the present generation and ensuring that future generations can also meet their own needs. These two statements together form the core of the Brundtland Commission's widely accepted definition. This approach requires a long-term perspective on resource management and environmental protection, emphasizing that current progress must not come at the expense of the well-being and life-support systems of those who will come after us.

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158. (D) Enhancing agricultural planning and productivity.
The primary purpose of dividing India into agro-climatic zones is to provide a scientific framework for enhancing agricultural planning and productivity. By classifying regions based on their unique combinations of climate, soil, and geography, researchers and policymakers can develop agricultural strategies that are specifically tailored to local conditions. This includes identifying the most suitable crops and farming techniques for each zone, which is essential for optimizing food production, improving resource efficiency, and ensuring the long-term sustainability of the agricultural sector.

159. (A) To provide reference data for verifying the accuracy of image analysis.
In a remote sensing project, the role of ground truthing is to provide accurate reference data that is used to verify and calibrate the results of digital image analysis. By making direct observations on the ground, scientists can confirm that the features identified in satellite imagery—such as different forest types or land uses—are correctly classified. This step is essential for assessing the accuracy of maps and ensuring that the final information extracted from remote sensing is reliable and scientifically valid.

160. (B) Identifying the cause of an environmental problem.
Geographic Information Systems are invaluable for identifying the causes of environmental problems by allowing scientists to overlay and analyze diverse spatial datasets. In the case study of coastal erosion, GIS helped reveal that a human-made structure altered natural processes like longshore drift. This ability to integrate information on terrain, historical changes, and human activity based on their common location is a core strength of GIS, making it an essential tool for understanding complex environmental issues and developing effective management solutions.

161. (B) Coal
Coal is a non-renewable natural resource because it takes millions of years to form from decaying plant matter under high pressure and temperature. Once extracted and burned, it cannot be replaced on a human timescale. In contrast, resources like wind, tidal energy, and timber from managed forests are considered renewable because they are naturally replenished or can be sustainably harvested over much shorter periods. The finite nature of non-renewable resources like coal is a major driver for transitioning to more sustainable energy systems.

162. (A) Both A and R are true and R is the correct explanation of A.
The Second Law of Thermodynamics dictates that in any energy transfer or transformation, some energy is inevitably converted into a less useful, disorganized form, typically low-quality heat. This increase in entropy means that no process can ever be one hundred percent efficient. This principle explains why energy is lost as it moves through food chains and why industrial machines cannot produce more energy than they consume. Understanding the Second Law is fundamental for analyzing the limits of energy efficiency in all systems.

163. (C) Absorb harmful ultraviolet radiation from the sun.
The primary role of the ozone layer in the stratosphere is to protect life on Earth by absorbing the vast majority of the sun's harmful ultraviolet (UV) radiation. By filtering out high-energy UV rays, the ozone layer prevents them from reaching the surface, where they would cause significant damage to living tissues, including skin cancers and damage to marine and terrestrial ecosystems. This protective function is essential for the survival of most organisms on the planet's surface and is a critical component of Earth's atmosphere.

164. (D) A single type of geographic feature, such as roads or rivers.
In a Geographic Information System (GIS), a 'layer' or 'theme' represents a single type of geographic feature or characteristic for a given area. For example, one layer might contain roads, another rivers, and a third land use types. By organizing spatial information into these distinct thematic layers, GIS allows users to easily visualize, manage, and analyze complex data. The ability to overlay these layers based on their common geographic location is the fundamental process that enables sophisticated spatial analysis and informed decision-making.

165. (C) Dry air
In meteorology, the 'mixing ratio' is a precise measure of humidity defined as the mass of water vapor divided by the mass of dry air in a given volume of air. It is typically expressed in units of grams of vapor per kilogram of dry air. Because it is calculated relative to dry air, the mixing ratio remains constant as an air parcel rises or sinks, as long as no moisture is added or removed through condensation or evaporation. This stability makes it a highly valuable parameter for tracking air masses.

166. (A) P-4, Q-3, R-1, S-2
Meteorological parameters are measured using specialized instruments. Air temperature is recorded with a thermometer, while atmospheric pressure is measured by a barometer. A hygrometer is used to determine the humidity or moisture content of the air, and an anemometer measures wind speed. These instruments provide the essential data for weather forecasting, climate monitoring, and environmental research, allowing scientists to quantify the physical state and dynamics of the atmosphere with precision across different locations and times.

167. (D) Melting Arctic sea ice reducing albedo and causing further melting.

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A positive feedback loop is a process that amplifies or accelerates an initial change. A significant environmental example is the melting of Arctic sea ice. As the ice melts, it reveals darker ocean water, which has a lower albedo and absorbs more solar radiation. This extra heat causes more ice to melt, further reducing the albedo and leading to more warming. This self-reinforcing cycle is a major concern in climate change studies as it can lead to rapid and irreversible environmental changes.

168. (A) Environmental Science
The core of environmental science is the scientific study of the interactions between living organisms and their environment. This includes examining how natural systems function and how they are affected by both natural processes and human activities. The discipline is inherently interdisciplinary, drawing on biology, ecology, chemistry, and other fields to understand these complex relationships. By investigating these interactions, environmental science provides the foundation for managing resources sustainably and protecting the health of the biosphere in a rapidly changing world.

169. (C) The use of computer algorithms to analyze and manipulate digital imagery.
Digital image processing in remote sensing refers to the use of computer algorithms and software to analyze, enhance, and manipulate digital imagery captured by satellite or aircraft sensors. This process includes correcting for geometric and radiometric distortions, enhancing the visual contrast of images, and using automated techniques like classification to extract meaningful information about land cover and environmental conditions. This conversion of raw sensor data into actionable geographic knowledge is a critical step in modern environmental monitoring and mapping projects.

170. (B) (a), (c), and (e) only
Environmental systems are characterized by a state of dynamic equilibrium, where they constantly adjust to changes while maintaining overall stability. The Earth is considered a closed system with respect to materials, as matter is recycled and rarely enters or leaves the planet's atmosphere. Furthermore, human culture and social structures are recognized as integral parts of the environment. Contrary to some views, environmental problems often cross political boundaries, necessitating international cooperation for effective management and protection of shared global resources.

171. (D) The sum of all regions on Earth where life exists.
The biosphere is most accurately described as the sum of all regions on Earth where life exists. It is the global ecological system that integrates all living beings and their relationships with the physical components of the atmosphere, hydrosphere, and lithosphere. From the deepest parts of the ocean to the high altitudes of the atmosphere where microbes can be found, the biosphere encompasses all ecosystems. It represents the thin, vibrant layer of the planet that supports the incredible diversity of life on Earth.

172. (B) Solar radiation
Solar radiation is the ultimate source of energy for almost all life within the biosphere. Through the process of photosynthesis, plants and other autotrophs capture solar energy and convert it into chemical energy, which then flows through the various trophic levels of food chains. In addition to powering biological systems, solar energy drives the Earth's climate, weather patterns, and the hydrological cycle. Without the continuous input of energy from the sun, most life as we know it would be unable to survive.

173. (C) Shared evolutionary history of their plants and animals
Biogeographic provinces are used to classify regions based on the shared evolutionary history of the plants and animals found within them. These regions are defined by unique assemblages of species that have developed over geological time, often in isolation due to physical barriers like mountains or oceans. By studying these provinces, scientists can understand the historical factors that have shaped current patterns of biodiversity. This biological classification differs from climate-based systems by focusing on the genetic and evolutionary relationships between organisms in a given area.

174. (A) (b), (d), (a), (c)

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In environmental science and ecology, biological systems are organized in a hierarchy of increasing complexity and scale. An individual organism is the basic unit. A group of organisms of the same species living in an area forms a population. An ecosystem includes the community of living organisms interacting with their physical, non-living environment. The biosphere is the highest level, encompassing the sum of all ecosystems on Earth. Understanding this order is essential for studying ecological processes at local, regional, and global scales.

175. (A) Layering of different types of spatial information for the same geographic area.
The fundamental concept behind a Geographic Information System (GIS) is the layering of different types of spatial information for the same geographic area. By organizing data into thematic layers—such as land use, roads, elevation, and population—GIS allows users to visualize and analyze how these different factors interact in space. The ability to overlay and combine these diverse datasets based on their common geographic coordinates is what enables the sophisticated spatial analysis and decision-making that is the hallmark of modern GIS technology.

176. (B) It is a static and unchanging field of study.
Environmental Science is characterized by its interdisciplinary, holistic, and dynamic nature. It integrates knowledge from various sciences and humanities to study the complex interactions between humans and the environment. Contrary to being static, the field is constantly evolving as new research provides a deeper understanding of ecological systems and as global environmental challenges change. It also encompasses social, ethical, and political aspects, recognizing that environmental issues cannot be solved through technical scientific knowledge alone, but require broader societal engagement.

177. (B) Condensation
Condensation is the physical process by which water vapor in the air is cooled and changes into its liquid form. This occurs when air reaches its saturation point, known as the dew point, often through cooling. Condensation is a critical step in the hydrological cycle, as it leads to the formation of clouds, fog, and dew. When water vapor condenses, it releases latent heat into the atmosphere, which is a major driver of energy transfer and weather phenomena across the Earth.

178. (A) That geological processes operate on very long time scales.
The principle that the present is the key to the past is known as uniformitarianism. When applied to the lithosphere, it suggests that the same geological processes we observe today, such as erosion and plate tectonics, have operated over Earth's long history. In environmental science, this principle helps us understand that many environmental changes occur on geological timescales and that current conditions are the result of processes acting over millions of years. This long-term perspective is essential for studying the Earth's evolution and environmental trends.

179. (C) Land use planning
When urban planners use GIS to analyze population density, park locations, and land availability to site new parks, they are applying the technology to land use planning. By integrating and overlaying these diverse spatial datasets, GIS can identify areas with the greatest need for green space and the most suitable locations for development. This spatial analysis ensures that planning decisions are evidence-based and promote efficient, sustainable urban environments that improve the quality of life for residents while protecting valuable natural resources.

180. (D) The energy flowing into the system must equal the energy flowing out plus any change in stored energy.
Applying the First Law of Thermodynamics to an ecosystem means recognizing that all energy entering the system must be accounted for. The law of conservation of energy states that the energy flowing into an ecosystem, primarily through solar radiation, must equal the energy flowing out—mostly as heat—plus any change in the energy stored in the biomass. This principle allows scientists to create energy budgets for ecosystems, providing a fundamental tool for understanding the productivity and efficiency of natural biological systems.

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181. (C) An unstable atmosphere with significant vertical mixing.
An unstable atmosphere with significant vertical mixing is the most conducive condition for the dispersal of air pollutants. In such an environment, air parcels are buoyant and rise easily, carrying pollutants away from the surface and into the upper atmosphere. This vertical movement, combined with horizontal winds, helps to dilute and spread emissions over a larger area, reducing ground-level concentrations. In contrast, stable conditions and temperature inversions trap pollutants near the surface, leading to poor air quality and increased health risks.

182. (B) Regional agricultural planning and resource management.
A map of India's fifteen agro-climatic zones is a specialized tool for regional agricultural planning and resource management. By visualizing the country according to areas with similar climate, soil, and geographical features, the map allows planners to develop strategies tailored to the unique environmental constraints of each region. This includes identifying suitable crops, managing water resources, and directing research to address zone-specific challenges, which is essential for maximizing sustainable agricultural productivity and supporting rural livelihoods across the diverse Indian landscape.

183. (A) (a), (c), and (d)
Remote sensing is the science of acquiring data about objects from a distance, such as from satellites or aircraft. It includes both passive sensors, which rely on external energy like sunlight, and active sensors, which provide their own energy and can thus operate during both day and night. Aerial photography is a well-established and common form of remote sensing. Understanding these different technologies and their capabilities is essential for choosing the right tools for various environmental monitoring and mapping tasks.

184. (A) What moral obligations do we have regarding the environment?
The most fundamental aspect of environmental ethics is examining the moral obligations that human beings have regarding the natural environment. It moves beyond technical questions of science or economics to ask about the rightness or wrongness of our actions toward nature. This includes exploring our duties to other species, to entire ecosystems, and to future generations. By addressing these core ethical questions, environmental ethics provides the moral guidance necessary for developing responsible and sustainable relationships between human society and the Earth.

185. (C) The name, length, and surface type of the roads.
In a Geographic Information System (GIS), attribute data consists of descriptive information about a geographic feature. For a 'roads' layer, while the spatial data defines the road's location and shape, the attribute data would include details such as the road's name, its length, and its surface type. This combination of where things are (spatial) and what they are like (attribute) is what makes GIS such a powerful tool for managing and analyzing complex information about the world around us.

186. (D) A is false but R is true.
Environmental education is not limited to children in schools but is a lifelong process necessary for all sectors of society. While formal education in schools and universities provides a structured foundation, non-formal and informal education through media, community programs, and professional training are also critical. Environmental awareness and action are needed from people of all ages to effectively address complex ecological challenges. A comprehensive approach that includes all these forms of education is essential for building an environmentally responsible and active citizenry.

187. (D) Troposphere
The troposphere is the layer of the atmosphere where temperature generally decreases with increasing altitude. On average, this decrease occurs at a rate of 6.5°C per kilometer, known as the environmental lapse rate. This cooling is caused by the heating of the Earth's surface by solar radiation, which then warms the air immediately above it. As air moves higher into the troposphere, it is further away from this primary heat source and at a lower pressure, resulting in lower temperatures.

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188. (B) Balancing economic, social, and environmental goals for well-being.
Sustainable development is best represented as a balanced approach that seeks to achieve economic prosperity, social equity, and environmental protection simultaneously. It is based on the idea that these three goals are interdependent and must be pursued together for long-term human well-being. By integrating environmental considerations into economic and social decision-making, sustainable development aims to ensure that current progress does not compromise the health of the planet or the opportunities available to future generations, promoting a more stable and resilient world.

189. (C) Radiation
Radiation is the only heat transfer process that does not require a physical medium to travel. It occurs through electromagnetic waves, allowing energy to pass through the vacuum of space. In contrast, conduction requires direct contact between substances, and convection depends on the movement of fluids like air or water. The ability of radiation to travel through a vacuum is why solar energy can reach the Earth from the Sun, making it the fundamental driver of our planet's energy cycles and climate.

190. (C) P-2, Q-1, R-4, S-3
Different ethical frameworks assign moral value in various ways. Anthropocentrism prioritizes human interests. Biocentrism extends moral value to all individual living things. Ecocentrism values entire ecological systems, including their non-living parts. Technocentrism is the belief that technological innovation can solve all environmental problems. These distinct viewpoints guide how society perceives its relationship with nature and the strategies it chooses for environmental protection and resource management, reflecting the diverse philosophical foundations of the field.

191. (A) Equal to zero
When applying a mass balance to a system at steady state, the accumulation term is exactly equal to zero. This means that the total mass of the substance entering the system is perfectly balanced by the total mass leaving it through all outputs and transformations. Steady state is a fundamental concept in environmental science used to model systems that have reached a condition where their properties remain constant over time, such as a lake with stable water levels and pollutant concentrations.

192. (B) Which areas are vulnerable to pollution based on land use and slope?
A Geographic Information System (GIS) is exceptionally useful for identifying areas that are vulnerable to environmental risks, such as pollution. By integrating and analyzing spatial data on land use, terrain slope, soil types, and hydrological patterns, GIS can model how pollutants might move through the landscape and identify where they are most likely to accumulate. This spatial analysis provides valuable insights for land use planning, disaster management, and the development of targeted strategies to protect sensitive environments and human health.

193. (B) Concerned with interconnected systems.
The study of bioaccumulation, where the concentration of a pollutant increases at higher levels of a food chain, demonstrates that environmental science is deeply concerned with interconnected systems. This process shows how a chemical released into the physical environment can travel through biological networks, ultimately affecting top predators and human health. Understanding these connections requires an interdisciplinary approach that links chemistry, biology, and ecology, highlighting the holistic nature of environmental science and its focus on the complex dependencies within the biosphere.

194. (A) Temperature
In meteorology and atmospheric science, the term 'lapse rate' refers specifically to the rate at which the temperature of the air changes as altitude increases. It is a fundamental parameter used to analyze atmospheric stability and predict weather patterns. The most common lapse rates are the environmental lapse rate, which is the actual observed temperature change in the ambient air, and the adiabatic lapse rates, which describe the temperature changes of rising or sinking parcels of air.

195. (C) Rocks and minerals
The lithosphere is the solid, rigid outer shell of the Earth, and its primary components are rocks and

minerals. It encompasses the Earth's entire crust and the brittle upper portion of the mantle. The lithosphere is characterized by its solid state and is the location of important geological processes such as erosion, soil formation, and tectonic plate movements. It provides the essential physical foundation for all terrestrial life and contains the planet's vast mineral and energy resources, making its study fundamental to geology and environmental science.

196. (D) The scope of Environmental Science
The study of how to create and manage sustainable human settlements and communities is a key aspect of the broad scope of environmental science. This involves integrating principles of ecology, urban planning, engineering, and sociology to design cities and towns that are resource-efficient, resilient, and promote a high quality of life while minimizing their environmental footprint. This interdisciplinary effort is essential for addressing the challenges of urbanization and ensuring that human development is compatible with the long-term health of the planet.

197. (C) The hydrosphere and atmosphere interact during the water cycle.
The Earth's spheres are constantly interacting in complex ways. A prime example is the water cycle, where the hydrosphere and atmosphere interact as water evaporates from oceans and later falls as precipitation. The atmosphere also exchanges gases with the biosphere and energy with the hydrosphere and lithosphere. These continuous interactions are what drive the planet's climate and support life. Contrary to being isolated, each sphere is part of a deeply integrated global system where changes in one have inevitable impacts on the others.

198. (B) The Second Law of Thermodynamics
An energy specialist analyzing the efficiency of a power plant would be most concerned with the Second Law of Thermodynamics. This law dictates that no energy conversion can be one hundred percent efficient, as some energy is always lost as low-quality heat. By understanding the limits imposed by the Second Law, engineers can work to optimize the performance of power plants and minimize waste. This principle is fundamental for improving energy efficiency and developing more sustainable energy production systems.

199. (D) Variable wind directions with no dominant direction.
A wind rose with equally long spokes in all directions indicates that the wind directions are highly variable, with no single dominant direction at that location over the measured period. This information is important for various environmental and engineering applications, as it suggests that wind patterns are inconsistent. In contrast, a wind rose with long spokes in only one or two directions would indicate a strong prevailing wind, which is a key factor in predicting air pollution dispersion or choosing sites for wind turbines.

200. (C) (a), (b), (c), and (d)
Sustainable development is a holistic concept based on the premise that natural resources are finite and must be managed responsibly. It involves making balanced decisions that account for environmental, social, and economic dimensions, often requiring a trade-off between meeting present needs and ensuring future well-being. This principle was officially adopted by the international community at the 1992 Rio Earth Summit. By integrating these diverse concerns, sustainable development seeks to ensure long-term planetary health and human prosperity through careful planning and interdisciplinary cooperation.

201. (C) Geothermal energy
Geothermal energy is considered a renewable natural resource because it is derived from the vast, continuous supply of heat generated within the Earth's interior. This heat is essentially inexhaustible on a human timescale. In contrast, fossil fuels like natural gas, petroleum, and crude oil, as well as minerals like uranium, are non-renewable because they take millions of years to form and exist in finite quantities that are being depleted far more quickly than they can be replaced by natural processes.

202. (A) Do other species have a right to exist, independent of their usefulness to humans?
Questions that explore the inherent rights of other species to exist, regardless of their utility to humans, fall squarely under the purview of

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environmental ethics. This field goes beyond the technical and chemical analysis of environmental problems to address the moral and philosophical foundations of our relationship with the natural world. By asking these fundamental questions, environmental ethics helps to define the values that guide conservation efforts, policy-making, and our individual and collective responsibilities toward the protection of biodiversity and ecosystems.

203. (D) Statement I is incorrect, but Statement II is correct.
The lithosphere is not a static layer but is dynamic and constantly changing due to plate tectonics. This fundamental theory describes how the rigid plates that make up the lithosphere move and interact at their boundaries. These movements are responsible for most of the Earth's major geological features and events, including mountain building, volcanic activity, and earthquakes. Understanding the dynamic nature of the lithosphere is essential for geology and for understanding how the Earth's surface has evolved and continues to change over time.

204. (B) Account for the flow and fate of a substance in a defined system.
The primary goal of a material balance analysis in environmental science is to systematically account for the flow and ultimate fate of a substance within a defined system. By tracking all inputs, outputs, and internal transformations, scientists can determine if a pollutant is accumulating, where it is going, and how its concentration might change. This quantitative approach is essential for managing resources, predicting environmental impacts, and developing effective strategies for pollution control and waste management in various natural and human systems.

205. (C) An active system
An active remote sensing system is characterized by its ability to provide its own internal source of energy to illuminate a target. The sensor emits a signal, such as a pulse of microwave or laser radiation, and then measures the portion of that signal that is reflected or scattered back from the target. This independence from external energy sources like the sun allows active systems, such as Radar and LiDAR, to operate effectively during both day and night and often through thick cloud cover.

206. (A) (b), (a), (d), (c)
The flow of energy in the environment follows a specific chronological sequence. It begins with solar radiation reaching the Earth's atmosphere. This energy is then absorbed by the land and water on the surface, causing them to warm up. Some of this absorbed energy is reradiated back into the atmosphere as infrared radiation. Finally, the uneven heating of the surface drives convection currents, which create wind and redistribute thermal energy. Understanding this sequence is fundamental to meteorology and the study of the Earth's climate.

207. (A) The Nearctic Realm
The Nearctic Realm is one of the world's major biogeographic realms, encompassing most of North America, including Greenland and the high-altitude regions of Mexico. Biogeographic realms are vast areas characterized by distinct assemblages of flora and fauna that have evolved in relative isolation over millions of years. While the Amazon and the Sahara are important biomes or ecological regions, they are components of larger realms. The classification of Earth into these vast realms is essential for understanding global patterns of biodiversity and evolution.

208. (A) Both A and R are true and R is the correct explanation of A.
An unstable atmosphere is characterized by conditions that promote vertical air movement. If an air parcel is lifted, it remains warmer and less dense than the surrounding ambient air at all altitudes. This creates buoyancy, causing the parcel to continue rising on its own. This upward motion facilitates the formation of convective clouds and allows for the effective mixing and dispersal of pollutants. Consequently, unstable conditions are often associated with active weather and good vertical visibility in the lower atmosphere.

209. (B) Analyzing the Normalized Difference Vegetation Index (NDVI) from satellite imagery to assess plant health.
Analyzing the Normalized Difference Vegetation Index (NDVI) is a common application of remote sensing for vegetation studies. NDVI is

a numerical indicator that uses the difference between the reflection of visible and near-infrared light to assess plant health and density. Because healthy vegetation reflects more near-infrared and less visible light, NDVI can identify areas of stress, track seasonal changes in growth, and monitor large-scale patterns of forest health and agricultural productivity from satellite imagery, providing critical data for environmental management.

210. (A) The rainforest is an interconnected system with a right to exist for its own sake.
The statement that a rainforest is an interconnected system with a right to exist for its own sake is a clear reflection of an ecocentric perspective. This ethical viewpoint holds that ecosystems have intrinsic value that is independent of any practical use or benefit to human beings. By focusing on the inherent rights and integrity of the whole ecological system, ecocentrism advocates for the protection of nature based on its own value, rather than valuing it only as a resource for human medicines or economic development.

211. (C) Tropopause
The tropopause is the specific boundary layer in the atmosphere that separates the troposphere below from the stratosphere above. It is defined as the altitude where the air temperature stops decreasing with height and remains constant or begins to increase. The tropopause acts as a physical lid on the troposphere, limiting the vertical movement of air and weather systems. Its height varies depending on latitude and season, typically being higher at the equator than at the poles.

212. (A) P-4, Q-3, R-2, S-1
Various natural processes are primary functions of specific Earth spheres. Photosynthesis is the central process of the biosphere, supporting most life. The hydrological cycle involves the movement and storage of water within the hydrosphere. Plate tectonics describes the dynamic movements of the solid lithosphere. Ozone formation is a critical chemical process occurring within the atmosphere. Understanding which sphere each process primarily belongs to is fundamental for studying the complex, interconnected systems of the Earth and how they sustain the planet.

213. (C) The temperature decreases, while the amount of water vapor remains constant.
Relative humidity is the ratio of the actual amount of water vapor in the air to the maximum amount it could hold at that specific temperature. Because warmer air can hold more moisture, if the amount of water vapor remains constant, the relative humidity will increase as the temperature decreases. Conversely, warming the air will decrease the relative humidity. This relationship is why morning dew often forms as the air cools overnight and why indoor air becomes dry when heated during winter.

214. (B) The maximum population size of a species that the environment can sustain indefinitely.
Carrying capacity is a fundamental ecological concept that refers to the maximum population size of a specific species that a given environment can sustain indefinitely. This limit is determined by the availability of essential resources such as food, water, and habitat, as well as environmental factors like waste accumulation and competition. If a population exceeds its carrying capacity, the environment may become degraded, leading to a population decline. Understanding this concept is essential for sustainable resource management and wildlife conservation.

215. (C) (c) and (d)
A Geographic Information System (GIS) uses two primary data models to represent information. The raster data model uses a continuous grid of cells, or pixels, making it ideal for phenomena like elevation or satellite imagery. The vector data model uses points, lines, and polygons for discrete features. A key function of GIS is to link this spatial data with detailed attribute data in a database. Together, these features allow GIS to integrate and analyze diverse spatial datasets, which is its most powerful capability.

216. (A) Environmental Science
The Brundtland Commission's definition of sustainable development is a core principle that falls squarely within the broad scope of environmental science. While it incorporates economic and social dimensions, the concept is fundamentally about managing human activities in a way that protects the Earth's natural life-support systems for the long term. This interdisciplinary approach is a defining

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characteristic of environmental science, which integrates knowledge from various fields to address the complex challenge of balancing human needs with ecological health and planetary stability.

217. (C) Radiation
The heat you feel from a campfire a few feet away is transferred primarily by radiation. This mechanism involves the emission of infrared waves that travel through the air and are absorbed by your body, directly warming you. While convection carries hot air upward above the flames and conduction would require you to touch the burning logs, radiation is the only process that can transfer thermal energy horizontally across the open space between the fire and yourself without needing direct physical contact.

218. (A) The global carbon cycle.
The study of the global carbon cycle is a primary example of applying the principle of material balance on a planetary scale. Scientists track the movement of carbon as it cycles through the atmosphere, oceans, lithosphere, and biosphere, accounting for all inputs, such as volcanic emissions and human-driven fossil fuel burning, and all outputs or sinks, such as forest growth and ocean absorption. This quantitative approach is essential for understanding how human activities are altering the Earth's energy balance and driving global climate change.

219. (D) A university classroom.
Formal environmental education is characterized by structured learning that takes place within the established school and university system. A university classroom is the most likely setting for this type of education, where students follow a prescribed curriculum, engage in academic research, and work toward a recognized degree. This formal approach provides a deep and systematic understanding of environmental principles and is distinct from non-formal learning that occurs through documentaries, museum exhibits, or community programs.

220. (B) Moral and ethical considerations
The principles of remote sensing are based on the physical sciences, specifically the interaction of electromagnetic radiation with the Earth's surface. This involves energy sources, sensors on various platforms, and the analysis of the data collected. While the information derived from remote sensing is used to inform environmental ethics and policy, the moral and ethical considerations themselves are not part of the technical principles that govern how remote sensing technology works. The field focuses on the quantitative and qualitative measurement of physical environmental properties.

221. (C) The SALR is less than the DALR because of the release of latent heat during condensation.
The main difference between the dry adiabatic lapse rate (DALR) and the saturated adiabatic lapse rate (SALR) is the rate of cooling. When a parcel of saturated air rises, the condensation of water vapor releases latent heat into the parcel. This internal heating partially offsets the cooling due to expansion, resulting in a saturated lapse rate that is lower than the dry rate of 10°C per kilometer. This difference is a key factor that meteorologists use to determine atmospheric stability and the potential for cloud formation.

222. (D) An inventory of minerals, water, forests, and soil.
A comprehensive assessment of natural resources for a specific region involves a detailed inventory of the area's physical and biological assets. This typically includes documenting the quantity and quality of minerals, water resources, forests, and soil types. Such an assessment provides the essential baseline data needed for informed land use planning and sustainable management. It allows policymakers to understand the potential for development and the need for conservation, ensuring that resources are used in a way that maintains long-term ecological and economic health.

223. (A) Both Statement I and Statement II are true.
The biosphere is accurately defined as the global region where life exists, and it is composed of countless ecosystems. Each ecosystem is a complex community of living organisms interacting with each other and their specific physical environment, such as a forest, a desert, or a lake. These systems are linked together through the flow of energy and the cycling of nutrients, forming the integrated and dynamic whole that is the biosphere. Understanding both

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the individual parts and their relationships is essential for studying global ecological health.

224. (B) Modeling the potential impact of sea-level rise on coastal communities.
A direct and important application of GIS for climate change studies is modeling the potential impacts of sea-level rise on coastal communities. By integrating high-resolution elevation data with population records and infrastructure maps, GIS can identify which areas are at the highest risk of flooding. This spatial analysis allows planners to visualize future scenarios and develop effective adaptation strategies, such as building defenses or relocating vulnerable populations, demonstrating how GIS technology provides actionable insights for managing the practical consequences of global environmental change.

225. (A) Both A and R are true and R is the correct explanation of A.
Environmental problems are inherently complex, often having multiple and interconnected causes that span physical, biological, and social systems. To understand and address these challenges effectively, environmental science must be an interdisciplinary field. It integrates knowledge from natural sciences like biology and chemistry with social sciences such as sociology and economics. This broad approach allows scientists to develop holistic solutions that consider both the technical aspects of environmental issues and the human behaviors and societal structures that drive them, ensuring more sustainable outcomes.

226. (A) Global weather and climate patterns.
The continuous transfer of mass and energy across the air-sea interface is a primary driver for global weather and climate patterns. This interface is where the exchange of heat, water vapor, and gases like carbon dioxide between the atmosphere and the oceans occurs. These processes regulate global temperatures, drive atmospheric circulation, and are essential components of the hydrological and carbon cycles. Understanding these interactions is critical for atmospheric science and for predicting how the Earth's climate system will respond to changes in greenhouse gas concentrations.

227. (C) Biocentrism
The ethical concept that all forms of life have an inherent right to exist is a fundamental cornerstone of biocentrism. This worldview grants moral standing to all living beings, regardless of their usefulness to humans, and argues that we have a moral obligation to respect and protect all life. By shifting the focus away from human-centered values, biocentrism provides a strong ethical foundation for biodiversity conservation and animal rights, challenging the traditional view that nature exists solely for human exploitation and resource management.

NODIA

228. (D) Mesosphere
The mesosphere is the layer of the Earth's atmosphere that has the lowest average temperature, with temperatures dropping as low as -90°C near the mesopause. It is located above the stratosphere and below the thermosphere. In this layer, temperature decreases with increasing altitude because there is little absorption of solar radiation. The thin air and the absence of warming mechanisms like the ozone layer in the stratosphere make the mesosphere the coldest region of the entire atmosphere, representing an extreme environment for study.

229. (A) (a), (b), and (c), and (d) only
The principles of remote sensing involve a series of logical steps: the process begins with an energy source, the energy interacts with a target on the Earth's surface, and a sensor records the reflected or emitted radiation. This data is then processed and analyzed to extract useful information about the environment. Crucially, remote sensing does not require the analyst to be physically present at the target location, which is its main advantage for studying large, remote, or inaccessible areas, providing a powerful tool for global observation.

230. (B) Waste management
Using GIS to determine the most efficient routes for garbage collection trucks is a practical and effective application of the technology in waste management. By analyzing spatial data on street layouts, traffic flow, and bin locations, GIS can optimize logistics to reduce fuel consumption, save time, and improve service efficiency. This demonstrates how GIS goes beyond simple mapping to provide sophisticated spatial problem-solving that helps cities manage their resources and infrastructure more sustainably

while reducing the environmental impact of municipal services.

231. (D) The absorption and re-emission of infrared radiation by gases.
The greenhouse effect is primarily caused by the absorption and re-emission of infrared radiation by certain gases in the atmosphere, such as carbon dioxide and methane. These gases allow shortwave solar radiation to pass through and reach the Earth's surface, but they trap the longwave infrared radiation emitted by the warm Earth. This process keeps the planet's surface significantly warmer than it would be otherwise, supporting life. However, human-driven increases in these gases are now causing an enhanced greenhouse effect and global warming.

232. (A) P-3, Q-4, R-1, S-2
Various environmental concepts can be linked to specific definitions or examples. Material balance is defined by the equation Input minus Output equals Accumulation. Adiabatic cooling describes the decrease in temperature of a rising air parcel. Ground truthing is the essential field process of verifying a digitally classified map. Anthropocentrism is a human-centered ethical viewpoint. These diverse terms from different scientific and philosophical fields together form the interdisciplinary language needed to study and manage the complex interactions between human society and the natural environment.

233. (C) Human activities have become a dominant force shaping environmental systems.
The most accurate view of the modern relationship between humans and the environment is that human activities have become a dominant force shaping the Earth's natural systems. This scale of influence, from global climate change to widespread habitat loss, is unprecedented in human history. While the environment still provides the resources and limits for human societies, the active and large-scale modification of ecosystems by people highlights the dynamic and reciprocal nature of this relationship, necessitating a focus on sustainable practices that protect the integrity of the biosphere.

234. (A) Meteorology
Meteorology is the scientific study of the atmosphere and its phenomena, focusing specifically on weather and weather forecasting. It involves the measurement and analysis of physical parameters such as temperature, pressure, humidity, and wind velocity to understand atmospheric dynamics and predict future states. While geology focuses on the lithosphere and hydrology on water systems, meteorology provides the scientific foundation for understanding the processes that drive our daily weather and the long-term patterns that define the Earth's various climates.

235. (D) Environmentally aware and willing to act.
A key and central objective of environmental education is to develop an informed citizenry that is both environmentally aware and willing to act. It seeks to empower individuals with the knowledge and skills needed to understand complex environmental issues and the motivation to participate in solving them. By fostering a sense of responsibility toward the Earth, environmental education encourages people to make sustainable choices in their own lives and to support public policies that protect the environment and promote long-term ecological health.

236. (B) A pixel or cell
The fundamental unit of analysis in a raster Geographic Information System (GIS) is the pixel, or cell. In this data model, the entire study area is divided into a continuous grid of these equally sized square cells, with each cell containing a single value that represents a specific geographic characteristic, such as elevation or land cover. The size of the pixel determines the spatial resolution of the data, with smaller pixels providing a more detailed representation of the environment for spatial analysis.

237. (C) Biomass
Biomass refers to the total mass of living or recently living biological material within a specific area or ecosystem. It is an important ecological measure that represents the amount of stored energy available at different trophic levels. Biomass includes everything from plants and trees to animals and microorganisms. In environmental science, measuring biomass is essential for studying ecosystem productivity, carbon storage, and the flow of energy through

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the biosphere, as well as for evaluating the potential for renewable bioenergy production.

238. (B) Statement I is correct, but Statement II is incorrect.
The laws of thermodynamics are fundamental principles that govern every transfer and transformation of energy and mass within the environment. They are essential for understanding how ecosystems function, how pollutants move through systems, and how to improve energy efficiency. Consequently, the study of thermodynamics is highly relevant and central to environmental science. It provides the physical framework needed to analyze the sustainability of both natural and human-made systems and is a core component of the scientific study of the environment.

239. (A) Developing region-specific agricultural strategies.
Dividing India into specific agro-climatic zones is a scientific approach designed to help in the development of region-specific agricultural strategies. By identifying areas with similar climate, soil, and geographical conditions, researchers can create farming plans that are perfectly suited to each unique environment. This regionalized strategy is essential for maximizing agricultural productivity, ensuring the efficient use of resources like water and fertilizer, and promoting sustainable land management that accounts for the diverse environmental challenges found across the different parts of the country.

240. (B) The air-water interface at the surface of a lake.
The air-water interface at the surface of a lake is a prime example of a boundary where mass and energy transfer are studied in environmental science. This interface is where critical processes such as evaporation, the exchange of gases like oxygen and carbon dioxide, and the transfer of heat from the sun occur. Understanding these interactions is essential for studying the lake's ecological health, the local hydrological cycle, and how water bodies respond to and influence the broader environmental and climatic conditions.

241. (B) Monitoring a rapidly changing event, such as a flood.
A satellite with high temporal resolution is designed to capture images of the same location very frequently. This capability is most suitable for monitoring rapidly changing environmental events, such as the progression of a flood, the spread of a wildfire, or the movement of a storm. By providing frequent updates, high temporal resolution allows scientists and emergency responders to track these dynamic situations in near real-time, providing the critical information needed for effective disaster management and time-sensitive environmental monitoring.

242. (A) Environmental ethics
Questions concerning our moral duties toward future generations with respect to the environment are central to the field of environmental ethics. This involves exploring the ethical foundations of sustainability and the responsibility of the present generation to maintain a healthy and resource-rich planet for those who will follow. By addressing these long-term moral issues, environmental ethics provides the philosophical reasoning for inter-generational equity and guides the development of policies that prioritize the long-term well-being of the biosphere over immediate, short-term gain.

243. (C) Absolutely stable
An atmosphere is described as absolutely stable when the environmental lapse rate (ELR) is less than the saturated adiabatic lapse rate (SALR). In this condition, any air parcel that is forced to rise, whether it is dry or saturated, will cool more quickly than its surroundings. As a result, the parcel will always be cooler and denser than the ambient air, causing it to sink back to its original level. This state strongly inhibits vertical air movement, cloud development, and the mixing of pollutants.

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244. (D) Geology
The lithosphere, which is the solid, rigid outer shell of the Earth, is primarily studied within the scientific field of geology. Geologists investigate the composition, structure, and processes of the lithosphere, including the study of rocks, minerals, plate tectonics, and historical changes to the Earth's surface. Understanding the lithosphere is fundamental to environmental science because it provides the physical foundation for all terrestrial ecosystems and is the primary source of the

mineral and soil resources upon which human society and the biosphere depend.

245. (C) An ethical guideline for human behavior towards the environment.
The principle of sustainability is best described as an ethical guideline for human behavior toward the environment. It is based on the goal of meeting present needs without compromising the ability of future generations to meet theirs. While it is informed by scientific data and economic theories, the concept itself is a value-based framework that encourages long-term responsibility and stewardship of natural resources. It serves as a moral compass for developing sustainable practices and policies that balance human development with ecological health.

246. (B) Water in all its forms (solid, liquid, gas) on, under, and over the Earth's surface.
In environmental science, the hydrosphere is a comprehensive term that includes all the water on, under, and over the surface of the Earth. It encompasses water in all its physical forms: liquid water in oceans, rivers, lakes, and groundwater; solid ice in glaciers and ice caps; and gaseous water vapor in the atmosphere. The hydrosphere is a dynamic system, with water constantly moving and changing state through the hydrological cycle, which is essential for supporting life and regulating the Earth's climate.

247. (D) First Law of Thermodynamics
The statement that energy can be transferred or transformed, but it cannot be created or destroyed, is the First Law of Thermodynamics, also known as the law of conservation of energy. This fundamental principle of physics applies to all environmental systems, from the flow of energy through a single cell to the global climate system. It means that the total amount of energy in a closed system remains constant, providing the essential foundation for creating energy budgets and analyzing the efficiency of biological and industrial processes.

248. (A) Monitoring changes in the landscape and informing sustainable management decisions.
The integrated application of remote sensing and GIS in land cover and land use planning is crucial for monitoring changes in the landscape over time. These technologies provide the tools needed to track trends such as urbanization, deforestation, and agricultural expansion. By providing accurate and timely spatial information, they inform sustainable management decisions and help planners develop strategies that protect valuable natural resources while meeting the needs of growing populations, which is essential for achieving long-term environmental and societal stability.

249. (C) It is a comprehensive field studying the interactions among physical, chemical, and biological components of the environment.
Environmental science is most accurately defined as a comprehensive and interdisciplinary field that studies the complex interactions among the physical, chemical, and biological components of the environment. Its scope includes understanding how natural systems function, how they are affected by human activities, and how to solve environmental problems through sustainable practices. By integrating knowledge from diverse scientific disciplines, environmental science provides a holistic understanding of the Earth system and is essential for managing the planet's resources and protecting the health of the biosphere.

250. (A) Conduction
Conduction is the process of heat transfer through a substance by molecular activity, involving the direct transfer of kinetic energy between neighboring particles. It occurs when faster-moving molecules in a warmer region collide with and transfer energy to slower-moving molecules in a cooler region. This mechanism is most effective in solids, where molecules are closely packed. In the environment, conduction is the primary way heat is transferred from the Earth's surface to the thin layer of air immediately above it, starting the process of atmospheric warming.

251. (B) The integration of multiple scientific disciplines to understand and solve environmental issues.
Environmental science is defined as an interdisciplinary academic field. It serves to integrate diverse physical, biological, and information sciences to address environmental issues comprehensively. This multidisciplinary nature allows researchers to study complex

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natural systems and find practical solutions to various pollution and management problems, rather than focusing on a single narrow scientific branch or purely political processes.

252. (A) The principle of material balance.
The law of conservation of matter establishes that mass is neither created nor destroyed. This physical reality underpins the principle that waste materials always persist in some form within the environmental system. Consequently, material balance calculations are used to track the input, output, and accumulation of substances, recognizing that discarded materials cannot simply disappear from the global ecosystem.

253. (C) the social, economic, and political aspects of human-environment relationships.
Environmental science possesses an exceptionally broad scope that transcends basic natural sciences. While it requires understanding the physical Earth spheres, it also deeply integrates the human element. Effective management of environmental problems necessitates analyzing social, economic, and political dimensions. This multi-faceted approach ensures that scientific solutions are practical and align with human societal structures and international policy frameworks.

254. (D) A holistic and interdisciplinary approach is necessary.
Complex environmental challenges, such as climate change, involve multifaceted interactions between natural and human systems. Addressing these issues effectively requires a holistic approach that draws knowledge from various fields like geology, chemistry, sociology, and economics. This interdisciplinary methodology allows for the formulation of comprehensive management strategies and policies that single-discipline perspectives cannot adequately provide for global sustainability.

255. (C) understand natural systems to facilitate wise environmental management.
The primary objective of studying environmental science is to gain a deep understanding of how the natural world functions and how human systems interact with it. This knowledge is not gathered for its own sake but to facilitate wise management of the environment. By understanding these complex relationships, society can better protect resources and ensure long-term ecological health.

256. (B) Exosphere
The Earth's atmosphere is stratified into several distinct layers based on their specific temperature profiles. The primary layers identified in standard atmospheric models include the troposphere, stratosphere, mesosphere, and thermosphere. While the exosphere is the outermost region of the atmosphere leading into space, it was not explicitly named in the provided description of the atmospheric structure and composition.

257. (D) 99%
The gaseous envelope surrounding the planet has a very specific chemical composition. Nitrogen accounts for approximately seventy-eight percent of the atmospheric gases, while oxygen makes up about twenty-one percent. When these two primary components are added together, they constitute ninety-nine percent of the atmosphere. This total excludes trace gases like argon, carbon dioxide, and various atmospheric pollutants.

258. (A) It constitutes a very small fraction of the total hydrosphere and is largely inaccessible.
Although the hydrosphere covers a large portion of the Earth's surface, most of this water is saline and located in the oceans. Freshwater accounts for only a tiny fraction of the total water volume. Furthermore, much of this freshwater is locked in ice caps or glaciers, making it largely inaccessible for direct human consumption or immediate ecosystem use.

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259. (C) is a composite zone of life overlapping with the atmosphere, hydrosphere, and lithosphere.
The biosphere is described as a global ecological system that integrates all living beings and their various relationships. Rather than being a separate, distinct layer, it is a composite zone of life that functions by overlapping with the lithosphere, hydrosphere, and atmosphere. It extends from the deep ocean floor up into the lower regions of the gaseous atmosphere.

260. (A) The crust and the upper mantle.
The lithosphere represents the rigid outermost shell of our planet. It provides the physical foundation for landmasses and the ocean floor. Geologically, this structural component consists

of two main parts: the Earth's crust and the solid, uppermost portion of the mantle. These parts are further divided into tectonic plates that move slowly over the more fluid asthenosphere below.

261. (D) The Second Law of Thermodynamics
The Second Law of Thermodynamics introduces the concept of entropy, which states that energy transformations are never perfectly efficient. During these processes, some energy is inevitably converted into low-grade heat, which is less useful for biological work. This results in a unidirectional flow of energy through trophic levels and explains why energy pyramids must always remain in an upright.

262. (B) The law of conservation of mass.
The principle of material balance serves as a fundamental framework for tracking nutrients and pollutants through environmental interfaces. It is a direct application of the law of conservation of mass, which states that matter cannot be created or destroyed. Therefore, any mass entering a specific system must eventually either leave that system or accumulate within its internal components.

263. (C) Radiation
Heat can be transferred through three primary physical processes: conduction, convection, and radiation. Conduction requires direct contact between substances, while convection involves the movement of fluids like air or water. Radiation is the unique process where energy travels through electromagnetic waves. Solar energy reaching the Earth from the sun is the most significant environmental example of this radiation process.

264. (D) The total amount of energy remains constant as it changes form within the system.
According to the First Law of Thermodynamics, energy is a conserved quantity that cannot be created or destroyed. In the context of an ecosystem, this means that energy is simply transformed from one form to another as it moves through the food web. While the quality of energy changes, the total amount within the closed system remains completely constant.

265. (A) convection, as it involves the movement of a fluid.
Convection is a heat transfer mechanism that occurs through the physical movement of fluids, which include both liquids and gases. When air masses in the atmosphere move due to temperature and pressure differences, they carry thermal energy with them. This movement of the air itself as a fluid medium makes it a classic example of convective heat transfer processes.

266. (B) Saturation mixing ratio
Humidity is a general term for the moisture content in the air, but specific metrics provide more precision. The mixing ratio measures the actual mass of water vapor present per unit of dry air. In contrast, the saturation mixing ratio defines the maximum possible amount of water vapor that a parcel of air can hold at a specific temperature.

267. (B) The environmental lapse rate and the adiabatic lapse rate.
Atmospheric stability is a critical factor influencing vertical air motion and the potential for storm development. This stability is determined by evaluating the relationship between two specific temperature changes with altitude. Scientists compare the environmental lapse rate, which is the actual temperature change, with the adiabatic lapse rate, which describes how a rising air parcel would naturally cool.

268. (A) When there is no heat exchange with the surrounding environment.
The adiabatic lapse rate is a specialized meteorological concept used to describe temperature changes within a rising or sinking parcel of air. A key condition of this process is that the air parcel does not exchange any heat with its surrounding environment. Instead, the temperature change results solely from internal pressure changes as the parcel moves vertically through the atmosphere.

269. (C) Humidity is a general term, while mixing ratio is a specific quantitative measure of water vapor relative to dry air.
Humidity serves as a broad, general term used to describe the presence of water vapor in the atmosphere. To achieve higher scientific accuracy, the mixing ratio is used as a specific quantitative measure. It defines the exact mass of water vapor

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relative to a unit mass of dry air, providing a more precise standard for meteorological calculations and analysis.

270. (D) The atmosphere is likely to be unstable, promoting vertical air motion.
Atmospheric stability is determined by comparing lapse rates. If the environmental lapse rate is significantly greater than the adiabatic lapse rate, it indicates that a rising parcel of air will remain warmer and less dense than the surrounding air. This condition creates an unstable atmosphere, which promotes strong vertical air motion and increases the likelihood of storm formation.

271. (C) To provide a graphical summary of wind speed and direction distribution over a period.
A wind rose is a specialized graphical tool used by meteorologists and environmental scientists. Its primary purpose is to provide a concise visual summary of how wind speed and direction are distributed at a specific location over a set time period. This chart allows for the rapid identification of complex wind patterns that numerical data alone cannot easily show.

272. (B) The frequency of wind blowing from that direction.
On a wind rose diagram, the spokes radiating from the center represent different compass directions. The length of each spoke is specifically proportional to the frequency with which the wind blows from that particular direction over the measurement period. Longer spokes indicate a more frequent wind source, while shorter spokes represent directions from which the wind blows less often.

273. (D) Because it possesses both magnitude (speed) and direction.
In physics and environmental science, a vector quantity is defined as a measurement that includes both a magnitude and a specific direction. Wind velocity fits this definition because it is characterized by its speed, which is the magnitude, and the compass direction from which it originates. Therefore, fully describing wind requires accounting for both of these essential components.

274. (A) Planning the orientation of an airport runway.
Prevailing wind directions determined from wind rose analysis are essential for many practical engineering and planning tasks. For airport runway design, the orientation must align with dominant wind patterns to ensure the safety of aircraft during takeoff and landing. This spatial information is more critical for physical infrastructure than for calculating atmospheric lapse rates or measuring daily rainfall amounts.

275. (C) The prevailing winds in that city are from the southeast.
A wind rose provides a visual representation of historical wind data. If the spokes pointing from the southeast are the longest on the chart, it indicates that the wind originated from that direction more frequently than any other during the observed timeframe. Therefore, a viewer can correctly infer that the southeast is the prevailing wind direction for that city.

276. (A) Long-term evolutionary isolation and unique species assemblages.
Biogeographic provinces are large geographical areas defined by their unique biological history. The primary basis for demarcating these regions is the long-term evolutionary isolation of organisms caused by physical barriers like oceans or mountain ranges. This isolation leads to the development of distinct assemblages of endemic species that are found nowhere else, distinguishing one province from another globally.

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277. (D) develop targeted agricultural strategies based on regional environmental conditions.
India utilizes agro-climatic zones to manage its diverse agricultural landscape effectively. These zones are demarcated based on environmental parameters such as rainfall, temperature, and soil characteristics. By dividing the country into areas with similar conditions, policymakers can develop targeted agricultural strategies. This regional approach helps in addressing specific constraints and maximizing the agricultural potential of different geographical areas.

278. (B) Economic viability, social equity, and environmental protection.
Sustainable development is a holistic framework designed to ensure long-term societal progress. It seeks to create a balance between three

fundamental pillars: economic viability, social equity, and environmental protection. By harmonizing these elements, the concept aims to meet current human needs without damaging the natural systems that future generations will depend upon for their own survival and continued development.

279. (C) It is a reciprocal relationship where human actions impact the environment that supports them.
The interaction between human societies and the Earth is characterized by a dynamic, reciprocal relationship. Human communities depend entirely on natural systems for resources and basic life support. Simultaneously, various human activities induce significant changes in the environment. This interaction means that the state of the environment is constantly shaped by human actions, which in turn affects human well-being.

280. (D) inter-generational equity and long-term resource management.
The core definition of sustainable development emphasizes the balance between current requirements and future possibilities. This focus highlights the critical importance of inter-generational equity, ensuring that today's resource consumption does not leave future populations with a degraded planet. Wise, long-term resource management is essential to maintain the Earth's capacity to support life and provide for all generations over time.

281. (A) Acquiring information about an object without direct physical contact.
Remote sensing is a sophisticated technology used to gather information about the Earth's surface. Its fundamental principle is the acquisition of data about an object or phenomenon without any direct physical contact. This is achieved by using sensors on satellites or aircraft to measure electromagnetic radiation that is either reflected or emitted from the target surface from a distance.

282. (B) system for analyzing and managing spatial data.
A Geographic Information System is a comprehensive computer-based framework. It is specifically designed to handle all aspects of spatial or geographical data, including its capture, storage, manipulation, and presentation. By integrating different data layers, the system allows for complex spatial analysis and queries, making it an essential tool for effective decision-making in urban planning and natural resource management.

283. (B) Remote sensing provides data that is analyzed within a GIS framework.
Remote Sensing and Geographic Information Systems are highly complementary technologies. Remote sensing acts as a primary data source by providing up-to-date, large-scale imagery of the Earth's surface. This digital information is then imported into a Geographic Information System, where it can be stored, analyzed, and integrated with other spatial data layers to support environmental monitoring and resource management.

284. (A) reflected or emitted from the surface of an object.
Sensors used in remote sensing platforms operate by detecting electromagnetic radiation. This energy is not generated by the sensor itself but is instead reflected or emitted from the surface of the objects being observed. By measuring the intensity and wavelength of this radiation, the sensors can identify different land cover types and monitor various environmental conditions from a distance.

285. (C) offer a synoptic view, or wide-area coverage, of the Earth's surface.
Satellite-based remote sensing offers several unique advantages for environmental monitoring. One of the most significant benefits is its ability to provide a synoptic view, which means it covers very large geographical areas in a single image. This wide-area perspective allows scientists to observe broad patterns and processes across the Earth's surface that would be impossible to see ground-level.

286. (D) To validate and assess the accuracy of information derived from imagery.
Ground truthing is a vital validation step in any remote sensing project. It involves the collection of actual field data from the Earth's surface to compare with the results derived from satellite imagery. This process is necessary to assess the accuracy of image classification and ensure that

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the digital interpretation of the environment correctly reflects the physical reality on ground.

287. (C) Correcting images for distortions and classifying them into themes.
Digital image processing involves the use of computer algorithms to refine and interpret raw satellite data. This comprehensive process includes performing radiometric and geometric corrections to remove distortions caused by the sensor or atmosphere. Additionally, it involves enhancing the images for better visualization and classifying pixels into thematic maps, such as those depicting different types of land cover.

288. (B) the integrated use of remote sensing and GIS.
Monitoring urban sprawling is a complex task that requires tracking changes in land use over time. This is best achieved through the integrated use of remote sensing and Geographic Information Systems. Satellite imagery provides the necessary data on building expansion, while the information system allows for the spatial analysis and mapping required to manage and plan for sustainable development.

289. (D) It contains distortions that need to be corrected through digital image processing.
Raw data captured by remote sensing satellites is rarely perfect upon arrival. It typically contains various sensor-induced distortions and atmospheric effects that can obscure the true signal from the Earth's surface. Therefore, this data must undergo digital image processing, including radiometric and geometric corrections, before it can be accurately used for scientific analysis or the creation of thematic maps.

290. (A) Classifying satellite imagery and then using targeted ground truthing to verify the classification.
For mapping forest types in large or inaccessible areas, a multi-step methodology is most efficient. First, digital image processing and classification of satellite imagery are used to identify potential forest categories across the entire region. Then, targeted ground truthing is performed at accessible locations to verify the accuracy of the classification, ensuring a reliable and high-quality final map.

291. (C) By integrating various spatial data layers to identify optimal, low-risk locations.
Geographic Information Systems are powerful tools for selecting optimal landfill sites. The system integrates various spatial data layers, such as soil type, topography, and groundwater depth. By analyzing these layers together, planners can identify locations that minimize environmental risks and social impacts. This data-driven approach ensures that the chosen site is the most suitable and sustainable option available.

292. (A) Measuring the retreat of glaciers and polar ice extent.
Remote sensing is an essential tool for scientists studying global climate change. It allows for the continuous monitoring of large-scale environmental indicators that are difficult to measure from the ground. Examples of these applications include tracking the retreat of glaciers and measuring the extent of polar ice caps, providing critical data on the rate and scale of global warming.

293. (D) By observing changes in the health of surrounding vegetation.
Remote sensing can effectively monitor the environmental impact of a landfill by observing changes in the surrounding landscape. Specifically, sensors can detect variations in the health and vigor of local vegetation. Since pollutants or changes in soil conditions often stress plants, observing these biological shifts from satellite or aerial imagery provides a non-invasive way to assess potential environmental degradation.

294. (B) providing and analyzing large-scale spatial data to monitor and quantify global changes.
The primary contribution of Remote Sensing and Geographic Information Systems to climate change research is the provision of spatial-temporal data. These technologies allow scientists to monitor and quantify large-scale global changes over long periods. By analyzing this information, researchers can validate complex climate models and identify which regions are most vulnerable to impacts like sea-level rise or significant desertification.

295. (C) A constraint or a factor to be minimized.

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When using a Geographic Information System for landfill site selection, planners must account for human impacts. Proximity to residential areas is a critical social factor that acts as a constraint. To minimize public health risks and social opposition, the distance between the disposal facility and homes is a parameter that should be minimized or managed within specific safe buffer zones.

296. (D) To encourage active participation in environmental protection.
Environmental education goes beyond simply teaching scientific facts about nature. Its ultimate goal is to transform knowledge and awareness into practical, pro-environmental behavior. By fostering the necessary attitudes and skills, this field aims to encourage individuals and communities to participate actively in environmental protection and become engaged in solving the various environmental problems facing the world today.

297. (A) the moral relationship between humans and the natural environment.
Environmental ethics is a specialized branch of philosophy that explores the moral dimensions of our world. Its primary concern is examining the relationship between human beings and the natural environment. This field addresses critical questions about the value of non-human entities and the specific moral duties that humans have towards protecting and preserving ecosystems for their own intrinsic worth.

298. (B) ecocentrism.
Different ethical frameworks assign value to the environment in various ways. Ecocentrism is a specific perspective that grants intrinsic value to whole ecosystems rather than just focusing on individual living organisms or human interests. This viewpoint recognizes that entire ecological systems have worth in themselves, which should guide human actions and policies towards a more sustainable and respectful relationship.

299. (B) Environmental ethics provides the moral foundation that environmental education seeks to foster in society.
Environmental education and environmental ethics are deeply interconnected fields. Ethics provides the fundamental moral framework and values that define our responsibility toward the Earth. Environmental education then serves as the practical tool to foster these ethical attitudes and awareness within society. Together, they aim to motivate individuals to adopt behaviors that reflect a commitment to environmental stewardship and protection.

300. (A) Anthropocentrism
Anthropocentrism is a human-centered ethical viewpoint. It suggests that moral standing and value are granted exclusively to human beings. When a policy argues for preserving a forest solely because it provides timber or recreation for people, it is valuing the natural resource based on its utility to humans rather than its own intrinsic right to exist or ecological importance.

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CHAPTER 02

Environmental Chemistry

1. In the context of environmental chemistry, stoichiometry is best defined as:
(A) The study of the speed and mechanisms of chemical reactions.
(B) The quantitative relationship between reactants and products.
(C) The study of heat and energy changes accompanying reactions.
(D) The equilibrium state of reversible environmental chemical reactions.

2. Which of the following is a key characteristic of water that makes it a universal solvent?
(A) Its molecular polarity and ability to form hydrogen bonds.
(B) Its notably low specific heat capacity and thermal property.
(C) Its inherently non-polar molecular structure and symmetry.
(D) Its unusually high density while in the solid state as ice.

3. Which of the following statements regarding the concept of Chemical Oxygen Demand (COD) is incorrect?
(A) COD measures the amount of oxygen required to chemically oxidize all organic material in water.
(B) The COD test uses a strong chemical oxidizing agent like potassium dichromate.
(C) The COD value is typically lower than the BOD value for the same water sample.
(D) COD can measure both biodegradable and non-biodegradable organic matter.

4. In atmospheric chemistry, what is a primary role of radicals?
(A) To absorb ultraviolet radiation, protecting the Earth's surface.
(B) To serve as condensation nuclei for cloud formation.
(C) To neutralize acidic components in rainwater samples.
(D) To act as highly reactive atmospheric chemical intermediates.

5. Match List-I with List-II regarding analytical principles.
List I: (Analytical Technique)
P. Titrimetry
Q. Gravimetry
R. Bomb Calorimetry
S. Flame Photometry
List II: (Principle/Measurement)
1. Measurement of the mass of a substance
2. Measurement of heat of combustion at constant volume
3. Measurement of emitted light intensity when an element is introduced to a flame
4. Measurement of the volume of a solution of known concentration
Codes:
(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-3, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-3, Q-1, R-2, S-4

6. Which of the following is considered an inorganic component of soil?
(A) Humus
(B) Clay minerals
(C) Bacteria
(D) Fungi

7. A chemical reaction has a negative Gibbs' energy ($\Delta G < 0$). What does this imply?
(A) The reaction is non-spontaneous and requires energy input.
(B) The reaction is currently maintained at equilibrium.
(C) The reaction rate is measured to be extremely fast.
(D) The reaction is spontaneous under the given conditions.

8. Identify the correct statement regarding Biochemical Oxygen Demand (BOD).

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(A) The dissolved oxygen required by aerobic organisms to decompose organic matter.
(B) The total oxygen consumption required for the chemical oxidation of aqueous pollutants.
(C) A notably low BOD value measured within a highly polluted aquatic environment.
(D) The standard BOD laboratory test typically conducted at 30°C over a 24-hour period.

9. Which of the following is NOT a greenhouse gas, but is a key component in the formation of photochemical smog?
(A) Carbon Monoxide (CO)
(B) Methane (CH_4)
(C) Volatile Organic Compounds (VOCs)
(D) Nitrous Oxide (N_2O)

10. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : In the absence of pollutants, the pH of natural rainwater is slightly acidic, around 5.6.
Reason (R) : Atmospheric carbon dioxide dissolves in water to form carbonic acid (H_2CO_3), which is a weak acid.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

11. What does the term chemical speciation refer to in environmental chemistry?
(A) The total measured concentration of a chemical element.
(B) The biological process of species formation in a system.
(C) The formal classification of chemicals based on toxicity.
(D) The distribution of an element among defined chemical species.

12. Given below are two statements.
Statement I : Saturated hydrocarbons contain only carbon-carbon single bonds.
Statement II : Unsaturated hydrocarbons contain at least one carbon-carbon double or triple bond.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

13. The process of removing colloidal particles from water by adding a chemical that causes them to aggregate is known as:
(A) Filtration
(B) Sedimentation
(C) Coagulation
(D) Disinfection

14. What is the primary function of a catalyst in the context of chemical kinetics?
(A) It increases the total Gibbs' energy of the specific reaction.
(B) It shifts the chemical equilibrium towards the product side.
(C) It becomes an integral part of the final chemical product.
(D) It increases the reaction rate without being consumed.

15. Consider the following statements about pesticides:
1. Pesticides are chemicals used to kill or control pests.
2. Organochlorines are a class of pesticides known for their high persistence in the environment.
3. Herbicides are a type of pesticide specifically used to control weeds.
4. All pesticides are synthetic and do not occur naturally.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 4 only
(B) 1, 3 and 4 only
(C) 1, 2 and 3 only
(D) 2 and 4 only

16. Redox potential (Eh) is a measure of:
(A) The precise acidity or alkalinity levels of a liquid solution.
(B) The tendency of a species to acquire electrons and be reduced.
(C) The total measured amount of dissolved solids within water.
(D) The heat capacity of a specific environmental chemical system.

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17. Which of the following heavy metals is strongly associated with the Itai-itai disease?
(A) Mercury (Hg)
(B) Cadmium (Cd)
(C) Lead (Pb)
(D) Chromium (Cr)

18. In the biogeochemical cycle of sulfur, which process involves the conversion of sulfate ($SO4^{2-}$) to hydrogen sulfide (H_2S) by bacteria under anaerobic conditions?
(A) Reduction
(B) Oxidation
(C) Mineralization
(D) Assimilation

19. The solubility of gases like oxygen in water generally:
(A) Increases as the temperature of the water increases.
(B) Is not affected by the temperature of the water.
(C) Decreases as the temperature of the water increases.
(D) Increases as the salinity of the water increases.

20. Consider the following statements about atmospheric particles:
1. They can act as condensation nuclei for cloud formation.
2. They are exclusively of natural origin.
3. They can influence the Earth's radiation balance.
4. Radicals are a type of stable, non-reactive atmospheric particle.
5. They can include both inorganic and organic matter.

Which of the above statement(s) is/are correct?
(A) 1, 3, and 5 only
(B) 2, 4, and 5 only
(C) 1, 2, and 3 only
(D) 1, 4, and 5 only

21. Peroxyacetyl nitrate (PAN) is a key component of:
(A) Acid rain
(B) Ozone layer depletion
(C) Photochemical smog
(D) London-type smog

22. The analytical technique that separates components of a mixture based on their differential distribution between a stationary phase and a mobile phase is:
(A) Spectrophotometry
(B) Chromatography
(C) Titrimetry
(D) Electrophoresis

23. Which of the following best describes a radioisotope?
(A) An atom that has recently gained or lost its valence electrons.
(B) An atom characterized by a stable and non-decaying nucleus.
(C) An atom with the same neutrons but different proton numbers.
(D) An atom with an unstable nucleus undergoing radioactive decay.

24. In the carbonate system in water, which species predominates at a pH value above 10.3?
(A) Carbonate ion ($CO3^{2}-$)
(B) Carbonic acid (H_2CO_3)
(C) Bicarbonate ion (HCO^{3-})
(D) Dissolved carbon dioxide (CO_2)

25. Arrange the following processes of the hydrological cycle in a logical sequence, starting from water on the Earth's surface.
1. Evaporation
2. Condensation
3. Precipitation
4. Infiltration

(A) 1, 2, 3, 4
(B) 2, 1, 4, 3
(C) 4, 1, 2, 3
(D) 1, 3, 2, 4

26. Which of the following is an example of an unsaturated hydrocarbon?
(A) Propene (C_3H_6)
(B) Methane (CH_4)
(C) Ethane (C_2H_6)
(D) Butane (C_4H_{10})

27. The primary source of stratospheric ozone (O_3) formation is the:
(A) Photodissociation of nitrogen dioxide by solar UV light rays.
(B) Oxidation of volatile organic compounds in

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the troposphere.
(C) Electrical discharge occurring during intense lightning storms.
(D) Reaction of atomic oxygen with molecular oxygen ($O + O_2 \longrightarrow O_3$).

28. Match List-I with List-II regarding toxic substances and their classification/effects.
List I: (Substance)
P. Benzene
Q. Dichlorodiphenyltrichloroethane (DDT)
R. Cadmium
S. Carbon Monoxide (CO)
List II: (Classification/Effect)
1. Organochlorine pesticide
2. Asphyxiant
3. Heavy metal
4. Carcinogenic VOC
Codes:
(A) P-1, Q-3, R-2, S-4
(B) P-4, Q-1, R-3, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-3, Q-1, R-4, S-2

29. The term chemical potential of a component in a mixture represents:
(A) The total thermodynamic internal energy of the specific mixture.
(B) The measured rate at which the specific component reacts.
(C) The change in Gibbs' energy per mole of the component added.
(D) The kinetic energy possessed by the component's molecules.

30. In soil science, what is the key process in the nitrogen cycle where microorganisms convert organic nitrogen into ammonium (NH4+)?
(A) Nitrification
(B) Denitrification
(C) Nitrogen Fixation
(D) Ammonification (Mineralization)

31. Which of the following analytical methods is most suitable for determining the elemental composition of a sample by measuring the characteristic X-rays emitted?
(A) X-ray Fluorescence (XRF)
(B) X-ray Diffraction (XRD)
(C) Nuclear Magnetic Resonance (NMR)
(D) Gas Chromatography (GC)

32. Which of the following is NOT a process involved in conventional water treatment?
(A) Coagulation
(B) Nitrification
(C) Flocculation
(D) Filtration

33. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Photochemical smog formation is initiated by the absorption of sunlight.
Reason (R) : The key initiating step is the photolysis of NO_2 to form NO and a highly reactive oxygen atom (O).
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

34. A Persistent Organic Pollutant (POP) is characterized by:
(A) Environmental stability, bioaccumulation, and long-range transport.
(B) High water solubility and rapid environmental degradation.
(C) Low toxicity and very short atmospheric environmental half-life.
(D) Gaseous state at room temperature and high chemical reactivity.

35. The process of flocculation in water treatment primarily involves:
(A) Killing pathogenic microorganisms within the water sample.
(B) Adjusting the pH level of the water to a neutral range.
(C) Gentle mixing to promote agglomeration of particles into flocs.
(D) Passing water through a porous medium to remove suspended solids.

36. Which statement best describes the principle of Atomic Absorption Spectrophotometry (AAS)?
(A) It measures the light absorbed by molecules in a solution.
(B) It measures the light emitted by excited atoms in a flame.
(C) It separates ions based on their specific

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mass-to-charge ratio.
(D) It measures light absorbed by ground-state atoms in a vapor.

37. The phosphorus cycle is different from the nitrogen and carbon cycles primarily because it:
(A) Does not involve living organisms.
(B) Occurs much more rapidly.
(C) Lacks a significant gaseous component in the atmosphere.
(D) Is not an essential nutrient for life.

38. The biochemical effect of mercury (Hg) often involves its strong affinity for:
(A) Phosphate groups in DNA.
(B) Sulfhydryl (-SH) groups in enzymes and proteins.
(C) The iron atom in hemoglobin.
(D) Calcium binding sites in bones.

39. In the context of chemical equilibria, what does Le Chatelier's principle state?
(A) At equilibrium, the rate of forward and reverse reactions are equal.
(B) The equilibrium constant is independent of temperature and pressure.
(C) For every action, there is an equal and opposite reaction force.
(D) Systems shift to relieve stress from applied changes in condition.

40. Consider the following statements regarding the composition of air:
1. Nitrogen and Oxygen together constitute about 99% of dry air by volume.
2. Argon is the third most abundant gas in the atmosphere.
3. The concentration of water vapor in the atmosphere is constant globally.
4. Carbon dioxide is considered a trace gas, but has a significant environmental impact.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 4 only
(B) 1, 2 and 3 only
(C) 2, 3 and 4 only
(D) 1, 3 and 4 only

41. What is the main purpose of using a bomb calorimeter?
(A) To measure the change in volume of a reaction.
(B) To determine the boiling point of a liquid under high pressure.
(C) To measure the heat of combustion of a substance.
(D) To analyze the explosive potential of a chemical.

42. Given below are two statements.
Statement I : Organophosphate pesticides are generally less persistent in the environment than organochlorine pesticides.
Statement II : Organophosphate pesticides act by inhibiting the enzyme acetylcholinesterase.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

43. Which technique would be most appropriate for identifying the crystal structure of a solid inorganic soil component?
(A) Gas Chromatography-Mass Spectrometry (GC-MS)
(B) Nuclear Magnetic Resonance (NMR)
(C) Thin-Layer Chromatography (TLC)
(D) X-ray Diffraction (XRD)

44. The formation of inorganic particulate matter in the atmosphere can occur through:
(A) The radioactive decay of radon.
(B) Gas-to-particle conversion processes.
(C) The dissolution of CO_2 in water droplets.
(D) The breakdown of stratospheric ozone.

45. Consider the following list of substances:
1. Dichlorodiphenyltrichloroethane (DDT)
2. Carbon Monoxide (CO)
3. Polychlorinated biphenyls (PCBs)
4. Dioxins
5. Ozone (O_3)

Which of the above statement(s) is/are classified as Persistent Organic Pollutants (POPs)?
(A) 1, 2, and 5 only
(B) 2, 3, and 5 only
(C) 1, 3, and 4 only
(D) 1, 4, and 5 only

46. What is the primary difference between Gas Chromatography (GC) and High-Performance Liquid Chromatography (HPLC)?
(A) The stationary phase in GC is liquid, while

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in HPLC it is solid.
(B) GC is used for solids, while HPLC is used for gases.
(C) GC provides quantitative data, while HPLC provides only qualitative data.
(D) The mobile phase in GC is a gas, while in HPLC it is a liquid.

47. In the context of environmental chemistry, a thermochemical reaction is one that is primarily driven by:
(A) Thermal (heat) energy
(B) Light energy
(C) Electrical energy
(D) Biological catalysts

48. The toxicity of the metalloid Arsenic (As) is highly dependent on its:
(A) Atomic mass
(B) Oxidation state and chemical form
(C) Isotopic form
(D) Physical state (solid, liquid, gas)

49. What role does pH play in the carbonate system of natural waters?
(A) It determines the color of the water.
(B) It controls the relative distribution of CO_2, HCO^{3-}, and $CO3^2-$.
(C) It has no effect on the carbonate species.
(D) It only affects the rate of photosynthesis.

50. Which process in the nitrogen cycle converts nitrates (NO^{3-}) back into gaseous nitrogen (N_2), returning it to the atmosphere?
(A) Denitrification
(B) Nitrogen Fixation
(C) Ammonification
(D) Nitrification

51. What is a primary difference between thermochemical and photochemical reactions in the atmosphere?
(A) Thermochemical reactions involve organic while photochemical involve inorganic.
(B) Thermochemical reactions occur during day while photochemical occur at night.
(C) Thermochemical are driven by heat while photochemical are initiated by light.
(D) Thermochemical reactions produce smog while photochemical produce acid rain.

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52. Match List-I with List-II regarding analytical techniques and their applications.
List I: (Analytical Technique)
P. GC-MS
Q. ICP-AES
R. FTIR
S. SEM
List II: (Typical Application)
1. Identification of functional groups in organic molecules
2. Imaging the surface morphology of a particle
3. Identification and quantification of volatile organic compounds
4. Multi-elemental analysis of trace metals in a water sample
Codes:
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

53. Lead (Pb) exposure poses a significant health risk, primarily affecting the:
(A) Respiratory system
(B) Digestive system
(C) Nervous system
(D) Endocrine system

54. The process where a solid is purified by causing it to pass directly from the solid to the gaseous state and back to the solid state is an application of:
(A) The standard principles of stoichiometry.
(B) Phase transitions driven by thermal changes.
(C) The concept of chemical reaction potential.
(D) The kinetics of radioactive nuclear decay.

55. In paper chromatography, the stationary phase is:
(A) The paper itself.
(B) The liquid solvent that moves up the paper.
(C) The bottom of the chromatography tank.
(D) The water molecules bound to the cellulose of the paper.

56. Which of the following is a primary mechanism for the formation of organic particulate matter in the atmosphere?
(A) Condensation of low-volatility organics from VOC oxidation.

(B) The reaction of sulfur dioxide with ammonium molecules.
(C) The erosion of rocks and soil caused by wind currents.
(D) The photodissociation of oxygen molecules by solar UV.

57. All of the following are significant anthropogenic sources of sulfur to the atmosphere EXCEPT:
(A) Burning of high-sulfur coal
(B) Smelting of sulfide ores
(C) Volcanic eruptions
(D) Petroleum refining

58. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The COD value of a water sample is always greater than or equal to its BOD value.
Reason (R) : The COD test uses a strong chemical oxidant that can oxidize nearly all organic compounds, including those that are not biodegradable.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

59. Which of the following statements about the hydroxyl radical (•OH) in the atmosphere is correct?
(A) It is a very stable and unreactive molecule.
(B) Its concentration is highest during the night.
(C) It is a major component of acid rain.
(D) It is known as the detergent of the troposphere.

60. The principle of gravimetric analysis is based on the:
(A) Measurement of the volume of a titrant.
(B) Weighing a pure compound related to the analyte.
(C) Measurement of the absorption of radiation.
(D) Measurement of the heat evolved in a reaction.

61. What is the main environmental concern associated with chromium (VI)?
(A) It causes eutrophication in water bodies.
(B) It bioaccumulates in the food chain as methylchromium.
(C) It is a known human carcinogen and highly toxic.
(D) It depletes the stratospheric ozone layer.

62. Arrange the following steps in the process of nitrification in the correct chronological order.
1. Oxidation of ammonia (NH^3) to nitrite (NO^{2-})
2. Bacterial uptake of organic nitrogen
3. Oxidation of nitrite (NO^{2-}) to nitrate (NO^{3-})
4. Mineralization of organic matter

(A) 4, 2, 1, 3
(B) 2, 4, 3, 1
(C) 1, 3, 2, 4
(D) 1, 3 only, as steps 2 and 4 are not part of nitrification.

63. Which analytical technique separates charged molecules in a solution under the influence of an electric field?
(A) Electrophoresis
(B) Flame Photometry
(C) Bomb Calorimetry
(D) Gravimetry

64. From a chemical kinetics perspective, the order of a reaction refers to:
(A) The sequence of elementary steps in the reaction mechanism.
(B) The sum of the exponents in the reaction rate law.
(C) The number of products formed in the chemical reaction.
(D) The spontaneity predicted by the Gibbs' energy change.

65. Consider the following statements about the ozone layer:
1. Stratospheric ozone absorbs harmful UV-B radiation.
2. Tropospheric ozone is a beneficial gas that cleans the air.
3. The breakdown of ozone in the stratosphere is a natural process.
4. The presence of chlorine radicals catalytically destroys stratospheric ozone.

Which of the above statement(s) is/are correct?

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(A) 1, 2 and 3 only
(B) 1, 3 and 4 only
(C) 2, 3 and 4 only
(D) 1, 2 and 4 only

66. Which of the following is a characteristic of a saturated hydrocarbon?
(A) It has the general formula $CnH_2n + 2$ for non-cyclic alkanes.
(B) It contains at least one carbon-carbon double bond.
(C) It readily undergoes addition reactions.
(D) It is typically more reactive than an unsaturated hydrocarbon.

67. The phenomenon where the concentration of a toxic substance increases in organisms at successively higher levels in a food chain is known as:
(A) Bioaccumulation
(B) Biodegradation
(C) Biomagnification
(D) Bioremediation

68. The principle of Nuclear Magnetic Resonance (NMR) spectroscopy is based on the:
(A) Diffraction of X-rays by the crystal lattice of a molecule.
(B) Emission of electrons from a surface when light shines on it.
(C) Separation of ions based on their mass-to-charge ratio.
(D) Radiofrequency absorption by nuclei in a magnetic field.

69. What is the most significant natural source of carbon monoxide (CO) in the atmosphere?
(A) Volcanic eruptions
(B) Forest fires
(C) Oxidation of methane (CH_4)
(D) Anaerobic decomposition in swamps

70. Consider the following components required for the formation of photochemical smog:
1. Sulfur dioxide
2. Sunlight
3. Nitrogen oxides (NOx)
4. Volatile organic compounds (VOCs)
5. Particulate matter from coal combustion

Which of the above statement(s) is/are correct?
(A) 1, 2, and 5 only
(B) 2, 3, and 4 only
(C) 1, 3, and 4 only
(D) 2, 4, and 5 only

71. A water sample with a high redox potential (Eh) value is indicative of:
(A) Anoxic conditions
(B) Reducing conditions
(C) Neutral pH conditions
(D) Oxidizing conditions

72. In Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES), what is the function of the plasma?
(A) To atomize and excite the atoms of elements in the sample.
(B) To separate the sample components by chromatography.
(C) To measure the mass of the specific ions produced.
(D) To absorb specific wavelengths of incident light rays.

73. The classification of pesticides as 'organochlorines', 'organophosphates', and 'carbamates' is based on their:
(A) Target pest
(B) Mode of application
(C) Chemical structure
(D) Persistence in the environment

74. Given below are two statements.
Statement I : Filtration is a physical process that removes suspended solids from water.
Statement II : Coagulation is a chemical process that destabilizes colloidal particles in water.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

75. The greenhouse effect is the process where certain atmospheric gases:
(A) Block incoming solar radiation.
(B) Catalyze the destruction of stratospheric ozone.
(C) React to form acid rain.
(D) Absorb and re-emit outgoing infrared radiation.

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76. The term humus refers to:
(A) The inorganic mineral fraction of the soil.
(B) Decomposed stable organic matter in the soil.
(C) The living microbial biomass in the soil.
(D) The parent rock material of the soil layer.

77. The technique of Scanning Electron Microscopy (SEM) is primarily used to obtain information about a sample's:
(A) Elemental composition
(B) Crystal structure
(C) Surface topography and morphology
(D) Molecular functional groups

78. Match the following atmospheric species with their primary role or characteristic.
List I: (Species)
P. O_3 (Stratosphere)
Q. •OH (Troposphere)
R. CO
S. SO_2
List II: (Role/Characteristic)
1. Precursor to acid rain
2. Asphyxiant from incomplete combustion
3. Primary absorber of UV-B radiation
4. Primary oxidizing agent or atmospheric detergent
Codes:
(A) P-1, Q-2, R-4, S-3
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-1, R-2, S-4
(D) P-4, Q-3, R-1, S-2

79. The solubility product constant (Ksp) is a measure of:
(A) The extent to which a sparingly soluble ionic compound dissolves.
(B) The rate of dissolution of a solid environmental pollutant.
(C) The total concentration of all ions in a standard solution.
(D) The pH level of a saturated chemical aqueous solution.

80. A carcinogen is a substance that is known to cause:
(A) Birth defects
(B) Cancer
(C) Genetic mutations
(D) Allergic reactions

81. Which of the following best represents a thermochemical process for the formation of inorganic particulate matter?
(A) Photolysis of NO_2 in the troposphere.
(B) High-temperature oxidation of SO_2 to SO_3.
(C) Reaction of O with O_2 to form ozone.
(D) Condensation of water vapor into clouds.

82. In Fourier Transform Infrared (FTIR) Spectroscopy, the resulting spectrum is a plot of:
(A) Transmittance or Absorbance vs. Wavenumber
(B) Absorbance vs. Wavelength
(C) Intensity vs. Mass-to-charge ratio
(D) Signal Intensity vs. Retention Time

83. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The biogeochemical cycle of phosphorus has a very small atmospheric component.
Reason (R) : Phosphorus compounds are generally non-volatile and exist primarily in soil, rock, and aquatic ecosystems.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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84. Minamata disease is associated with poisoning by which toxic substance?
(A) Lead
(B) Cadmium
(C) Arsenic
(D) Methylmercury

85. Which of the following is a primary role of sedimentation in water treatment?
(A) To kill bacteria and viruses in water.
(B) To adjust the pH levels of the water.
(C) To remove heavy particles by gravity.
(D) To add oxygen to the treated water.

86. The main difference between ICP-AES and ICP-MS is that:
(A) ICP-AES uses a plasma, while ICP-MS does not.
(B) ICP-AES measures light; ICP-MS measures

mass-to-charge.
(C) ICP-AES is organic; ICP-MS is for inorganic analysis.
(D) ICP-AES is less sensitive than ICP-MS in most cases.

87. Which process is NOT part of the carbon cycle?
(A) Photosynthesis
(B) Respiration
(C) Combustion of fossil fuels
(D) Denitrification

88. What is the fundamental principle of Thin-Layer Chromatography (TLC)?
(A) Partitioning between an adsorbent plate and a solvent.
(B) Separation based on chemical boiling points of liquids.
(C) Separation based on molecular size using a gel matrix.
(D) Separation based on charge in an applied electric field.

89. The term residence time of a chemical species in the atmosphere refers to the:
(A) Time taken for the species to react completely.
(B) Time required for its concentration to double.
(C) Average time a molecule remains in the atmosphere.
(D) Time it takes for the species to reach the stratosphere.

90. Consider the following statements about Volatile Organic Compounds (VOCs):
1. They are organic chemicals that have a high vapor pressure at ordinary room temperature.
2. All VOCs are of anthropogenic origin.
3. They are key precursors in the formation of photochemical smog.
4. Methane is often considered separately from other VOCs due to its lower reactivity.

Which of the above statement(s) is/are correct?
(A) 1 and $_2$ only
(B) 2 and 3 only
(C) 1, 3 and 4 only
(D) 1, 2, 3 and 4

91. The half-life of a radioisotope is defined as:
(A) The total time it takes for the isotope to decay completely.
(B) The time the isotope remains chemically active in the environment.
(C) Half of the total measured atomic mass of the radioisotope.
(D) The time required for half of the atoms to undergo decay.

92. Which of the following conditions would favor a low Dissolved Oxygen (DO) concentration in a river?
(A) Low water temperature and rapid flow.
(B) High water temperature and high load of organic waste.
(C) High rate of photosynthesis by aquatic plants.
(D) Low atmospheric pressure and low salinity.

93. The technique of Transmission Electron Microscopy (TEM) is used to:
(A) View the surface of a sample.
(B) Determine the elemental composition of a sample.
(C) Obtain images of the internal structure of a thin specimen.
(D) Identify the functional groups present in a molecule.

94. The biochemical aspect of selenium (Se) toxicity is complex because:
(A) It is not an element found in biological systems.
(B) It is toxic at all concentrations.
(C) It only affects plants and not animals.
(D) It is an essential micronutrient at low concentrations but toxic at high concentrations.

95. Consider the following characteristics of Persistent Organic Pollutants (POPs):
1. They are resistant to environmental degradation.
2. They are highly soluble in water.
3. They can undergo long-range atmospheric transport.
4. They bioaccumulate in fatty tissues of living organisms.
5. They have very short environmental half-lives.

Which of the above statement(s) is/are correct?

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(A) 1, 2, and 3 only
(B) 2, 3, and 5 only
(C) 1, 3, and 4 only
(D) 2, 4, and 5 only

96. What is the significance of the rate-determining step in a multi-step chemical reaction?
(A) It is the fastest step in the reaction mechanism.
(B) It is the step that determines the overall rate.
(C) It is the only reversible step in the mechanism.
(D) It is the final step that forms the reaction product.

97. Polycyclic Aromatic Hydrocarbons (PAHs) are a group of organic compounds often found in the air, and many are considered carcinogens. A major source of PAHs is:
(A) The dissolution of carbonate rocks.
(B) The incomplete combustion of organic materials.
(C) The reaction of nitrogen and oxygen at high temperatures.
(D) The radioactive decay of uranium.

98. In spectrophotometry, Beer-Lambert's law states that absorbance is directly proportional to:
(A) The concentration and path length of the light.
(B) The wavelength of the light and the temperature.
(C) The intensity of the incident light source rays.
(D) The volume of the sample and its specific pH.

99. Which of the following is a primary function of the hydrological cycle?
(A) To fix atmospheric nitrogen into a usable form for plants.
(B) To create fossil fuels over geological time.
(C) To regulate climate and redistribute water globally.
(D) To generate the Earth's magnetic field components.

100. Given below are two statements.
Statement I : Titrimetry is a quantitative analytical method.
Statement II : Gravimetry determines the amount of an analyte by measuring the mass of a precipitate.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

101. The concept of chemical equilibrium applies to:
(A) All chemical reactions.
(B) Only reactions that go to completion.
(C) Reversible reactions where the rates of the forward and reverse reactions are equal.
(D) Only photochemical reactions.

102. An example of a carbamate pesticide is:
(A) DDT
(B) Carbaryl
(C) Malathion
(D) Glyphosate

103. Match the biogeochemical cycle with its key reservoir.
List I: (Cycle)
P. Carbon Cycle
Q. Nitrogen Cycle
R. Phosphorus Cycle
S. Sulphur Cycle
List II: (Key Reservoir)
1. Sedimentary Rocks
2. Atmosphere
3. Oceans and Atmosphere
4. Oceans and Rocks
Codes:
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-4, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-1, R-4, S-2

104. Which atmospheric radical is formed from the photolysis of ozone by UV light ($< 3_20$ nm)?
(A) Excited atomic oxygen (O(1D))
(B) Atomic chlorine (Cl•)
(C) Nitric oxide (NO•)
(D) Hydroperoxyl radical (HO_2•)

105. What is the primary environmental advantage of HPLC over traditional column chromatography?
(A) It can only be used for gaseous samples.
(B) It requires larger sample volumes.
(C) It offers high resolution, speed, and sensitivity.

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(D) It does not use a stationary phase material.

106. In an aquatic environment, if the rate of respiration is greater than the rate of photosynthesis, what is the likely impact on Dissolved Oxygen (DO)?
(A) DO levels will decrease.
(B) DO levels will increase.
(C) DO levels will remain constant.
(D) DO will be converted to COD.

107. Which of the following is NOT a characteristic of a chemical reaction at equilibrium?
(A) The concentrations of reactants and products are constant.
(B) The forward and reverse reaction rates are equal.
(C) The Gibbs' energy change (ΔG) for the reaction is zero.
(D) The reaction has stopped completely.

108. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Organochlorine pesticides like DDT are subject to biomagnification.
Reason (R) : These compounds are lipophilic (fat-soluble) and persistent, causing them to accumulate in the fatty tissues of organisms and be transferred up the food chain.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

109. What is the primary purpose of the flame in Flame Photometry and Atomic Absorption Spectrophotometry (AAS)?
(A) To combust the sample completely to CO_2 and H_2O.
(B) To serve as a high-intensity chemical light source.
(C) To vaporize the sample into free ground-state atoms.
(D) To ionize the sample for mass spectroscopic analysis.

110. Which part of the electromagnetic spectrum is primarily responsible for initiating photochemical reactions in the troposphere?
(A) Infrared (IR)
(B) Microwave
(C) X-ray
(D) Ultraviolet (UV) and Visible

111. The toxicity of carbon monoxide (CO) to humans is primarily due to its ability to:
(A) Bind hemoglobin, reducing oxygen-carrying capacity.
(B) Destroy biological lung tissue during inhalation.
(C) Cause permanent mutations in cellular DNA structures.
(D) Act as a potent greenhouse gas in the atmosphere.

112. Arrange the following chromatographic techniques in the likely chronological order of their invention/development.
1. High-Performance Liquid Chromatography (HPLC)
2. Paper Chromatography
3. Gas Chromatography (GC)
4. Thin-Layer Chromatography (TLC)

(A) 1, 3, 4, $_2$
(B) 2, 4, 3, 1
(C) 2, 3, 1, 4
(D) 3, 2, 4, 1

113. A reducing environment in soil or sediment would be characterized by:
(A) A high positive Eh and presence of O_2, NO^{3-}, and SO^{42-}.
(B) A negative Eh and presence of CH_4, H_2S, and Fe^{2+}.
(C) A high positive Eh and presence of CH_4, H_2S, and Fe^{2+}.
(D) A negative Eh and presence of O_2, NO^{3-}, and $SO4^{2-}$.

114. The combination of Gas Chromatography with Mass Spectrometry (GC-MS) is powerful because:
(A) GC separates compounds and MS provides identification.
(B) GC provides structure and MS separates the compounds.
(C) Both techniques measure the absorption of

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infrared.
(D) It allows for the analysis of non-volatile solids.

115. Consider the following statements about the carbonate system in water:
1. It acts as a major pH buffer in most natural waters.
2. The dominant species at pH 7 is the bicarbonate ion (HCO^{3-}).
3. The system involves an equilibrium between dissolved CO_2, carbonic acid, bicarbonate, and carbonate ions.
4. Total alkalinity is primarily contributed by species other than those of the carbonate system.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3 only
(B) 2, 3 and 4 only
(C) 1 and 4 only
(D) 1, 2, 3 and 4

116. Which of these is a primary air pollutant?
(A) Ozone (O_3) in the troposphere
(B) Sulfuric acid (H_2SO_4) in acid rain
(C) Peroxyacetyl nitrate (PAN)
(D) Carbon monoxide (CO) from car exhaust

117. What property is measured in titrimetry to determine the concentration of an analyte?
(A) Mass of a precipitate.
(B) Intensity of light absorbed.
(C) Volume of a standard solution required to react completely with the analyte.
(D) Electrical potential of an electrode.

118. In the context of toxicology, the term LD50 refers to:
(A) The level of detection for 50% of analytes.
(B) The dose lethal to 50% of a test population.
(C) A 50-day period of exposure to a toxin.
(D) The dose causing a 50% reduction in enzyme activity.

119. The process of nitrogen fixation involves the conversion of:
(A) Nitrate (NO^{3-}) to N_2 gas.
(B) Organic nitrogen to ammonium (NH^{4+}).
(C) Ammonia (NH_3) to nitrate (NO^{3-}).
(D) Atmospheric nitrogen to nitrogenous compounds.

120. Consider the following statements regarding aspects of oxygen and ozone chemistry in the atmosphere:
1. The Chapman cycle describes the basic formation and destruction of stratospheric ozone.
2. The photolysis of O_2 by UV-C radiation (< $_24_2$ nm) produces two oxygen atoms.
3. Tropospheric ozone is formed by the same mechanism as stratospheric ozone.
4. An oxygen atom (O) reacts with an oxygen molecule (O_2) to form ozone (O_3).
5. Ozone is a more powerful oxidizing agent than molecular oxygen.

Which of the above statement(s) is/are correct?
(A) 1, 2, 4, and 5 only
(B) 2, 3, 4, and 5 only
(C) 1, 3, and 5 only
(D) 1, 2, and 3 only

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121. The parent material of a soil refers to:
(A) The organic humus layer on top.
(B) The microbial community within the soil.
(C) The underlying geological material from which the soil is formed.
(D) The vegetation growing on the soil.

122. Which analytical technique is based on the principle of measuring the characteristic X-rays emitted after an electron is ejected from an atom?
(A) X-ray Fluorescence (XRF)
(B) UV-VIS Spectrophotometry
(C) Photoelectron Spectroscopy
(D) NMR Spectroscopy

123. Which of the following is considered a major source of indoor air pollution, releasing VOCs like formaldehyde?
(A) Radon seeping from the ground.
(B) Unvented gas stoves.
(C) House plants during nighttime respiration.
(D) Pressed wood products and furniture.

124. The rate of a first-order chemical reaction is dependent on:
(A) The square of the reactant concentration.
(B) The concentration raised to the power of one.
(C) The measured concentration of the product.
(D) The temperature independently of

concentration.

125. Which of the following is NOT typically classified as one of the major nutrient biogeochemical cycles?
(A) The Nitrogen Cycle
(B) The Phosphorus Cycle
(C) The Oxygen Cycle
(D) The Sulphur Cycle

126. Given below are two statements.
Statement I : The redox potential (Eh) of water is a measure of its electron-accepting or electron-donating capacity.
Statement II : A positive Eh indicates an oxidizing environment, while a negative Eh indicates a reducing environment.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

127. Which type of chromatography would be most suitable for separating volatile compounds like the components of gasoline?
(A) Gas Chromatography (GC)
(B) Paper Chromatography
(C) Thin-Layer Chromatography (TLC)
(D) Electrophoresis

128. Match the pollutant with its primary health effect.
List I: (Pollutant)
P. Lead (Pb)
Q. Asbestos fibers
R. Carbon Monoxide (CO)
S. Ground-level Ozone (O_3)
List II: (Health Effect)
1. Asphyxiation
2. Respiratory irritation
3. Neurotoxicity
4. Lung cancer (mesothelioma)
Codes:
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

129. The formation of photochemical smog is a complex process. Which of the following is a secondary pollutant formed during this process?
(A) Nitrogen monoxide (NO)
(B) Ozone (O_3)
(C) Hydrocarbons (HC)
(D) Sulfur dioxide (SO_2)

130. What is the fundamental difference between AAS and Flame Photometry?
(A) AAS measures absorbed light, while Flame Photometry measures emitted light.
(B) AAS uses a flame, while Flame Photometry uses a plasma.
(C) AAS is for non-metals, while Flame Photometry is for metals.
(D) There is no fundamental difference; the terms are interchangeable.

131. In the context of soil chemistry, cation exchange capacity (CEC) is a measure of the soil's ability to:
(A) Retain water against the force of gravity.
(B) Decompose organic matter.
(C) Hold and exchange positively charged ions (cations).
(D) Resist changes in pH.

132. Henry's Law is relevant to environmental chemistry because it describes the:
(A) Rate of a chemical reaction.
(B) Spontaneity of a chemical process.
(C) Effect of temperature on reaction kinetics.
(D) Equilibrium partitioning between phases.

133. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The hardness of water is primarily caused by the presence of dissolved Ca_2+ and Mg_2+ ions.
Reason (R) : These divalent cations react with soap to form an insoluble precipitate, reducing its lathering ability.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

134. Which of the following techniques would be best suited for providing a high-magnification

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image of the internal crystalline structure of a nanomaterial?
(A) Scanning Electron Microscopy (SEM)
(B) Transmission Electron Microscopy (TEM)
(C) Atomic Force Microscopy (AFM)
(D) UV-VIS Spectrophotometry

135. The main environmental concern with CFCs (chlorofluorocarbons) is their role in:
(A) Forming photochemical smog.
(B) Causing acid rain.
(C) Acting as potent greenhouse gases.
(D) Depleting the stratospheric ozone layer.

136. The biochemical aspect of cadmium (Cd) toxicity includes its ability to interfere with which essential element's metabolism?
(A) Zinc and Calcium
(B) Iron
(C) Sodium
(D) Potassium

137. Which of the following best describes the principle of UV-VIS spectrophotometry?
(A) It measures the emission of light by a sample after excitation.
(B) It measures the mass of particles based on their charge.
(C) It measures light absorption by a solution.
(D) It measures the vibrations of chemical bonds in a molecule.

138. In the global carbon cycle, which of the following is the largest reservoir of carbon?
(A) The oceans
(B) The atmosphere
(C) Terrestrial vegetation
(D) Fossil fuel deposits

139. The Rf value in Paper Chromatography and TLC is calculated as:
(A) (distance by solvent) / (distance by spot)
(B) (distance by spot) x (distance by solvent)
(C) Time taken for the spot to travel distance.
(D) (distance by spot) / (distance by solvent)

140. Consider the following statements regarding radicals in the atmosphere:
1. They are highly reactive species with an unpaired electron.
2. The hydroxyl radical (•OH) is a key oxidant in the troposphere.
3. Radicals are stable and persist for long durations in the atmosphere.
4. The formation of radicals often requires energy from sunlight (photolysis).

Which of the above statement(s) is/are correct?
(A) 1 and 3 only
(B) 2, 3 and 4 only
(C) 1, 2 and 4 only
(D) 1, 2, 3 and 4

141. The reaction `$CaCO_3(s) + H_2CO_3(aq) \rightleftarrows Ca(HCO_3)^2(aq)$` is important in which environmental process?
(A) Formation of photochemical smog pollutants.
(B) The fixation of atmospheric nitrogen gas.
(C) Weathering of limestone and water hardness.
(D) The destruction of stratospheric ozone layers.

142. A major source of arsenic (As) contamination in groundwater is:
(A) Industrial wastewater discharge into rivers.
(B) Leaching from agricultural soil pesticides.
(C) Atmospheric deposition from volcanic activity.
(D) Natural geological mobilization in soil.

143. Which of the following techniques is NOT a chromatographic method?
(A) Inductively Coupled Plasma - Mass Spectrometry (ICP-MS)
(B) Gas Chromatography (GC)
(C) High-Performance Liquid Chromatography (HPLC)
(D) Thin-Layer Chromatography (TLC)

144. What is meant by the activation energy of a chemical reaction?
(A) The total energy released during the reaction.
(B) Minimum energy for reactant transformation.
(C) The energy difference between product and reactant.
(D) The specific energy supplied by a chemical catalyst.

145. Consider the following substances:

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1. Carbon Monoxide (CO)
2. Sulfur Dioxide (SO_2)
3. Ozone (O_3)
4. Peroxyacetyl Nitrate (PAN)
5. Nitrogen Dioxide (NO_2) emitted from vehicle exhaust

Which of the above statement(s) is/are considered primary air pollutants?
(A) 3 and 4 only
(B) 1, 2, and 5 only
(C) 1, 2, 3, and 4 only
(D) All of the above

146. The process in the sulfur cycle where organic sulfur is converted into inorganic forms like hydrogen sulfide (H_2S) is called:
(A) Mineralization or decomposition
(B) Oxidation
(C) Assimilation
(D) Photolysis

147. Given below are two statements.
Statement I : Coagulation and flocculation are primarily aimed at removing dissolved substances from water.
Statement II : Filtration is effective at removing suspended particles but not dissolved ions.
(A) Both Statement I and Statement II are false.
(B) Both Statement I and Statement II are true.
(C) Statement I is false, but Statement II is true.
(D) Statement I is true, but Statement II is false.

148. Which heavy metal is a liquid at room temperature and can be biomethylated by microorganisms into a more toxic form?
(A) Lead (Pb)
(B) Cadmium (Cd)
(C) Chromium (Cr)
(D) Mercury (Hg)

149. The chemical potential of a pure substance is identical to its:
(A) Molar enthalpy
(B) Molar entropy
(C) Molar Gibbs energy
(D) Molar heat capacity

150. London smog is characteristically different from photochemical smog in that it:
(A) Occurs in warm, sunny conditions.
(B) Is characterized by high concentrations of sulfur dioxide and particulate matter.
(C) Is rich in ozone and oxidizing agents.
(D) Is caused primarily by automobile exhaust.

151. Which of the following is a key step in the biogeochemical cycle of phosphorus?
(A) Fixation from the atmosphere by lightning.
(B) Gaseous emission from volcanoes.
(C) Reduction of phosphate to phosphine gas by bacteria.
(D) Uptake of phosphate from soil and water by plants.

152. Match the analytical technique with the property it primarily measures or the principle it uses.
List I: (Technique)
P. XRD
Q. NMR
R. XRF
S. FTIR
List II: (Property/Principle)
1. Absorption of radio waves by nuclei in a magnetic field
2. Identification of elements by their characteristic emitted X-rays
3. Diffraction of X-rays by the crystalline lattice
4. Absorption of infrared radiation by molecular vibrations

Codes:
(A) P-1, Q-3, R-4, S-2
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-4, R-3, S-1

153. A chemical species is classified as an ion in the atmosphere if it:
(A) Has an unpaired electron.
(B) Is in a gaseous state.
(C) Carries a net positive or negative electrical charge.
(D) Is an aggregate of many molecules.

154. What is the role of the mobile phase in chromatography?
(A) It carries components through the stationary phase.
(B) It is the stationary medium on which separation occurs.
(C) It reacts chemically with the analyte in the mixture.

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(D) It is the detector that visualizes separated components.

155. Which of the following is an example of a saturated hydrocarbon?
(A) Benzene
(B) Ethene
(C) Acetylene
(D) Cyclohexane

156. The term speciation is critically important for assessing the toxicity of metals like chromium and arsenic because:
(A) The total concentration is the only relevant factor.
(B) Chemical forms have vastly different toxicities.
(C) All species of a metal are considered equally toxic.
(D) Speciation only affects the color of the compound.

157. The Chapman reactions describe the formation and destruction of:
(A) Photochemical smog in the troposphere.
(B) Acid rain from SO_2 emissions.
(C) The natural ozone layer in the stratosphere.
(D) The carbonate system in oceans.

158. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : An increase in the concentration of reactants will generally increase the rate of a chemical reaction.
Reason (R) : According to collision theory, a higher concentration of reactants leads to a greater frequency of collisions between reacting particles.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

159. Which class of pesticides is known for its high acute toxicity to mammals and its mechanism of inhibiting acetylcholinesterase?
(A) Organophosphates
(B) Organochlorines
(C) Pyrethroids
(D) Herbicides

160. What is the primary difference between Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)?
(A) DO is for pollution, while BOD measures purity.
(B) DO is oxygen present; BOD is oxygen required.
(C) DO is measured over 5 days; BOD is instantaneous.
(D) DO applies to rivers, while BOD applies to lakes.

161. An 'aliquot' in titrimetry refers to:
(A) The indicator used to signal the endpoint.
(B) A precisely measured volume of a solution.
(C) The entire volume of the unknown solution.
(D) The standardized solution in the burette.

162. Arrange the major components of dry air in order of decreasing abundance.
1. Argon
2. Oxygen
3. Carbon Dioxide
4. Nitrogen
(A) 4, 2, 3, 1
(B) 4, 1, 2, 3
(C) 4, 2, 1, 3
(D) 2, 4, 1, 3

163. The primary mechanism of toxicity for many heavy metals, such as lead (Pb) and mercury (Hg), involves:
(A) Causing thermal burns to biological tissues.
(B) Acting as a physical abrasive on cell surfaces.
(C) Disrupting enzyme function by binding to sites.
(D) Increasing the pH level of aquatic bodily fluids.

164. What does a high value for the Octanol-Water Partition Coefficient (Kow) of a pollutant signify?
(A) The substance is highly soluble in water.
(B) The substance is highly volatile in air.
(C) The substance degrades quickly in the environment.
(D) The substance is lipophilic and bioaccumulates.

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165. Consider the following statements about analytical techniques:
1. XRF is a non-destructive technique for elemental analysis.
2. GC is suitable for analyzing non-volatile, high molecular weight polymers.
3. FTIR provides information about functional groups in a molecule.
4. SEM provides a two-dimensional image of the internal structure of a sample.

Which of the above statement(s) is/are correct?
(A) 1 and 3 only
(B) 2 and 4 only
(C) 1, 2 and 3 only
(D) 1, 3 and 4 only

166. A reaction is at chemical equilibrium when:
(A) The concentration of reactants is zero.
(B) The change in Gibbs' energy (ΔG) is zero.
(C) The temperature of the system is at its maximum.
(D) All molecular motion ceases.

167. Which of the following is NOT a major process in the hydrological cycle?
(A) Evaporation
(B) Condensation
(C) Transpiration
(D) Nitrogen fixation

168. The primary purpose of flocculation, following coagulation, in a water treatment plant is to:
(A) Encourage particles to collide and form flocs.
(B) Disinfect the water from biological pathogens.
(C) Filter out fine particles from the water sample.
(D) Adjust the water's pH level to a neutral state.

169. Dioxins and furans are highly toxic POPs that are often formed as unintentional byproducts of:
(A) Photosynthesis in common green plant species.
(B) The natural decay of radioactive nuclear isotopes.
(C) Combustion of organic material with chlorine.
(D) The Haber-Bosch process for industrial synthesis.

170. Consider the following conditions for the catalytic destruction of stratospheric ozone by chlorine:
1. Presence of chlorine atoms (Cl•).
2. Presence of ozone (O_3).
3. Absorption of infrared radiation.
4. Formation of a chlorine monoxide radical (ClO•) as an intermediate.
5. High concentrations of nitrogen.

Which of the above statement(s) is/are correct?
(A) 1, 2, and 4 only
(B) 2, 3, and 5 only
(C) 1, 3, and 4 only
(D) 1, 2, and 5 only

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171. A major role of organic components (humus) in soil is to:
(A) Provide the primary mineral rock structure.
(B) Cause the soil to become strongly acidic.
(C) Eliminate all soil-dwelling microbial life.
(D) Increase water-holding capacity and nutrients.

172. The term stoichiometric coefficient in a balanced chemical equation represents:
(A) The rate constant of the specific reaction.
(B) The molar ratio of consumption and formation.
(C) The activation energy of the chemical reaction.
(D) The equilibrium constant of the chemical reaction.

173. What is the main difference between ICP-AES and AAS?
(A) ICP-AES is organic, while AAS is inorganic.
(B) ICP-AES provides structure, AAS provides concentration.
(C) ICP-AES uses plasma emission, AAS uses absorption.
(D) ICP-AES requires solid, while AAS requires liquid.

174. Which of the following is a primary role of sedimentation in water treatment?
(A) To kill bacteria and viruses in water.
(B) To adjust the pH levels of the water.
(C) To remove heavy particles by gravity.
(D) To add oxygen to the treated water.

175. Given below are two statements.

Statement I : Radioisotopes are atoms with unstable nuclei that emit radiation.
Statement II : All isotopes of an element are radioactive.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

176. Which of the following is a key feature of photochemical reactions in the atmosphere?
(A) They occur primarily at night.
(B) They are initiated by the absorption of photons.
(C) They are always endothermic.
(D) They do not involve free radicals.

177. The most toxic form of arsenic commonly found in natural waters is:
(A) Elemental arsenic (As(0))
(B) Arsenite (As(III))
(C) Arsenate (As(V))
(D) Arsine gas (AsH3)

178. Match the following terms related to water quality with their correct descriptions.
List I: (Term)
P. DO
Q. BOD
R. COD
S. pH
List II: (Description)
1. Measure of oxygen required for chemical oxidation
2. Measure of hydrogen ion concentration
3. Measure of oxygen required for microbial decomposition
4. Concentration of oxygen dissolved in water
Codes:
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-1, Q-3, R-4, S-2

179. The purpose of a 'blank' sample in spectrophotometry is to:
(A) Calibrate the wavelength of the instrument.
(B) Increase the signal from the specific analyte.
(C) Correct for solvent and cuvette absorbance.
(D) Check the linearity of the Beer-Lambert plot.

180. The primary environmental impact of sulfur dioxide (SO_2) is its role as a:
(A) Greenhouse gas
(B) Stratospheric ozone-depleting substance
(C) Carcinogen
(D) Precursor to acid rain

181. What does the stationary phase in HPLC typically consist of?
(A) A gas adsorbed on a solid support material.
(B) A liquid solvent pumped at high pressure.
(C) Fine porous silica or polymer packed in columns.
(D) A piece of standard laboratory filter paper.

182. A chemical reaction with a large, positive change in Gibbs' energy ($\Delta G >> 0$) will be:
(A) Spontaneous in the forward direction.
(B) Non-spontaneous in the forward direction.
(C) At equilibrium.
(D) Very rapid.

183. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Photochemical smog is an oxidizing smog.
Reason (R) : It contains high concentrations of oxidants such as ozone (O3) and peroxyacetyl nitrate (PAN).
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

184. In soil chemistry, what is the source of the negative charge on clay mineral surfaces?
(A) Isomorphic substitution of cations in the lattice.
(B) Adsorption of protons from standard soil water.
(C) The presence of decaying organic matter in soil.
(D) The radioactive decay of potassium-40 isotopes.

185. The analytical technique that uses the diffraction pattern of X-rays scattered by a crystalline solid to determine its structure is:

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(A) XRF
(B) SEM
(C) XRD
(D) TEM

186. Which of the following is NOT a property of water acting as a universal solvent?
(A) Low surface tension
(B) High dielectric constant
(C) Polarity
(D) Ability to form hydrogen bonds

187. The half-life of Carbon-14 is approximately 5730 years. This property is used in:
(A) Medical imaging.
(B) Nuclear power generation.
(C) Treatment of cancer.
(D) Radiocarbon dating of organic materials.

188. Which of the following conditions promotes the solubility of gases in water?
(A) High temperature and high pressure
(B) Low temperature and high pressure
(C) High temperature and low pressure
(D) Low temperature and low pressure

189. A key difference between GC-MS and LC-MS (HPLC-MS) is:
(A) The type of detector used.
(B) GC-MS can identify compounds, while LC-MS cannot.
(C) The type of mobile phase used for separation.
(D) GC-MS is for liquids, and LC-MS is for gases.

190. Consider the following statements about heavy metal toxicity:
1. Heavy metals are typically defined as metals with high density or high atomic weight.
2. The toxicity of a metal is independent of its chemical form or speciation.
3. Some heavy metals, like zinc and copper, are essential nutrients at low concentrations.
4. Heavy metals can disrupt enzyme function by binding to sulfhydryl groups.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3 only
(B) 2, 3 and 4 only
(C) 1, 3 and 4 only
(D) 1, 2 and 4 only

191. The sum of the concentrations of carbonic acid, bicarbonate, and carbonate in a water sample is referred to as:
(A) Total inorganic carbon (TIC)
(B) Total dissolved solids
(C) Hardness
(D) Salinity

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192. Which of the following is a characteristic of an organic soil component?
(A) It is derived from the weathering of rocks.
(B) It is composed of decaying plant and animal matter (humus).
(C) It consists primarily of silicon and aluminum oxides.
(D) It includes sand, silt, and clay particles.

193. The principal mechanism for the natural cleansing of the troposphere from many pollutants is oxidation by:
(A) Molecular oxygen (O_2)
(B) The hydroxyl radical (•OH)
(C) Stratospheric ozone (O_3)
(D) Nitrogen gas (N_2)

194. In the context of the classification of elements, metalloids exhibit properties that are:
(A) Intermediate between those of metals and non-metals.
(B) Identical to metals.
(C) Identical to non-metals.
(D) Similar to noble gases.

195. Consider the following statements regarding water treatment processes:
1. Sedimentation relies on gravity to remove dense particles.
2. Filtration is a physical barrier method to remove suspended solids.
3. Coagulation involves adding chemicals to destabilize colloidal particles.
4. Flocculation uses vigorous, rapid mixing to break up particles.
5. pH adjustment is often necessary for optimal coagulation.

Which of the above statement(s) is/are correct?
(A) 1, 2, 3, and 5 only
(B) 1, 2, 4, and 5 only
(C) 2, 3, and 4 only
(D) 1, 3, and 5 only

196. The main purpose of FTIR spectroscopy in environmental analysis is to:
(A) Determine the concentration of heavy metals.
(B) Obtain a high-resolution surface image of a particle.
(C) Measure the heat of a reaction.
(D) Identify unknown organic compounds by their functional groups.

197. The process of converting ammonia to nitrate (via nitrite) by microorganisms is known as:
(A) Denitrification
(B) Nitrogen fixation
(C) Nitrification
(D) Ammonification

198. The 'end point' in a titration is typically observed by:
(A) A change in temperature.
(B) A color change of an indicator.
(C) A change in pressure.
(D) The formation of a precipitate.

199. What are the three main components required for the formation of photochemical smog?
(A) SO2, particulate matter, and water vapor
(B) CO, CO2, and CFCs
(C) O_3, H_2SO_4, and HNO_3
(D) NOx, VOCs, and sunlight

200. Given below are two statements.
Statement I : Saturated hydrocarbons are also known as alkanes.
Statement II : Unsaturated hydrocarbons, such as alkenes and alkynes, are generally more reactive than alkanes.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

201. Which analytical technique would be most suitable for the quantitative analysis of sodium and potassium in a water sample?
(A) NMR Spectroscopy
(B) X-ray Diffraction
(C) Flame Photometry
(D) Gravimetry

202. The chemical potential is a useful thermodynamic concept for predicting the direction of:
(A) Mass transfer or phase change
(B) Heat flow
(C) Electron flow
(D) Radioactive decay

203. Match the radioisotope with its common application or significance.
List I: (Radioisotope)
P. Carbon-14
Q. Uranium-235
R. Cobalt-60
S. Radon-2_{22}
List II: (Application/Significance)
1. Nuclear reactor fuel
2. Indoor air pollutant (natural origin)
3. Radiometric dating
4. Gamma radiation source for sterilization/ radiotherapy
Codes:
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-4, R-3, S-1

204. Which of the following is NOT a typical characteristic of a Persistent Organic Pollutant (POP)?
(A) High persistence in the environment
(B) High water solubility
(C) Bioaccumulation in fatty tissues
(D) Potential for long-range transport

205. The primary difference between SEM and TEM is that:
(A) SEM uses electrons, while TEM uses X-rays.
(B) SEM is for biological samples, while TEM is for geological samples.
(C) SEM provides surface images; TEM provides internal structures.
(D) SEM provides elemental composition; TEM provides molecular structure.

206. In an Eh-pH diagram for water, the region of water stability is bounded by:
(A) The freezing and boiling points of water.
(B) The concentrations of dissolved salts.
(C) The boundaries of the carbonate system.
(D) Lines of water oxidation to O2 and reduction to H2

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207. Which of the following best describes the principle of gravimetric analysis?
(A) The analyte is separated as a precipitate and weighed.
(B) The volume of a reagent required for reaction is measured.
(C) The amount of light absorbed by the analyte is measured.
(D) The sample is burned and the heat released is measured.

208. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The hydroxyl radical (•OH) has a very short lifetime in the troposphere.
Reason (R) : It is an extremely reactive species that rapidly reacts with most trace gases in the atmosphere.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

209. What class of compounds, including substances like DDT and PCBs, is known for its extreme persistence and tendency to biomagnify?
(A) Organophosphates
(B) Organochlorines
(C) Carbamates
(D) Pyrethroids

210. The concept that a system at equilibrium will adjust to counteract a disturbance is known as:
(A) Le Chatelier's Principle
(B) Henry's Law
(C) The Law of Mass Action
(D) The First Law of Thermodynamics

211. Which form of chromatography uses a liquid mobile phase pumped through a column packed with a solid stationary phase?
(A) Paper Chromatography
(B) Gas Chromatography (GC)
(C) High-Performance Liquid Chromatography (HPLC)
(D) Thin-Layer Chromatography (TLC)

212. Arrange the following steps of the phosphorus cycle in a plausible sequence, starting from rocks.
1. Weathering of rocks releases phosphates.
2. Plants absorb phosphates from the soil.
3. Animals consume plants.
4. Decomposition returns phosphates to the soil.

(A) 1, 4, 2, 3
(B) 1, 2, 3, 4
(C) 2, 3, 4, 1
(D) 4, 1, 2, 3

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213. The main toxic action of carbon monoxide is:
(A) Its ability to destroy the ozone layer.
(B) Its property as a potent greenhouse gas.
(C) High affinity for hemoglobin, displacing oxygen.
(D) Its role as a precursor to acid rain.

214. In mass spectrometry, mass-to-charge ratio is the parameter used to separate molecules based on their:
(A) Polarity
(B) Mass-to-charge ratio
(C) Boiling point
(D) Light absorption properties

215. Consider the following statements about biogeochemical cycles:
1. The nitrogen cycle involves fixation, nitrification, and denitrification.
2. The primary reservoir for phosphorus is the atmosphere.
3. The carbon cycle is significantly influenced by both natural processes and human activities.
4. The sulfur cycle includes both atmospheric and terrestrial components.

Which of the above statement(s) is/are correct?
(A) 1, 2, and 3 only
(B) 1, 3, and 4 only
(C) 2 and 4 only
(D) All of the above

216. The Aufbau principle and Hund's rule are concepts related to:
(A) The classification of elements based on electron configuration.
(B) The kinetics of chemical reactions.
(C) The stoichiometry of chemical equations.

(D) The laws of thermodynamics.

217. In the analysis of heavy metals, what is the key advantage of ICP-MS over AAS?
(A) Lower cost and simplicity.
(B) It does not require sample digestion.
(C) Simultaneous multi-element analysis at low limits.
(D) It can only be used for solid samples.

218. The formation of inorganic particulate matter in the atmosphere, such as ammonium sulfate, is an example of a:
(A) Gas-to-particle conversion process.
(B) Homogeneous nucleation process only.
(C) Photodissociation reaction.
(D) Radioactive decay process.

219. Which of the following represents a chemical equilibrium?
(A) $H_2O(l) \rightarrow H_2O(g)$ at 100°C and 1 atm
(B) $C(s) + O_2(g) \rightarrow CO_2(g)$ burned to completion
(C) A radioisotope decaying over time
(D) $N_2(g) + 3H_2(g) \rightleftharpoons {}_2NH_3(g)$ in a closed container

220. Consider the following statements about the composition of air and related chemistry:
1. The most abundant element in Earth's atmosphere is Nitrogen (N_2).
2. Oxygen (O_2) is largely a product of photosynthesis.
3. Ozone (O_3) is beneficial in the stratosphere but a pollutant in the troposphere.
4. Ions and radicals are short-lived, reactive species in the atmosphere.
5. Saturated hydrocarbons are more reactive in the atmosphere than unsaturated ones.

Which of the above statement(s) is/are correct?
(A) 1, 2, 3, and 4 only
(B) 2, 3, 4, and 5 only
(C) 1, 3, and 5 only
(D) All of the above

221. The BOD5 test measures the amount of oxygen consumed by microorganisms in a water sample over:
(A) 5 hours at 25°C
(B) 5 minutes at 100°C
(C) 5 days at 20°C
(D) 5 days at 30°C

222. Given below are two statements.
Statement I : Chemical speciation refers to the different physical and chemical forms in which an element can exist.
Statement II : The toxicity and mobility of a metal like Chromium is independent of its speciation.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

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223. What is the primary cause of Minamata disease?
(A) Ingestion of seafood contaminated with methylmercury.
(B) Exposure to high levels of lead from gasoline.
(C) Inhalation of asbestos fibers.
(D) Drinking water contaminated with cadmium.

224. In the context of the carbonate system, Henry's Law constant (KH) relates the partial pressure of CO_2 in the air to:
(A) The concentration of carbonate ions ($CO3_2^-$) in water.
(B) The concentration of dissolved aqueous CO2
(C) The pH of the water.
(D) The total alkalinity of the water.

225. A thermochemical reaction is one that is principally governed by:
(A) The absorption of light.
(B) The input or release of heat.
(C) The influence of a catalyst.
(D) The presence of radioisotopes.

226. What is the fundamental unit measured in a Bomb Calorimeter?
(A) Change in temperature
(B) Change in pressure
(C) Change in volume
(D) Change in mass

227. A major source of airborne carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) is:
(A) Volcanic eruptions
(B) The use of nitrogen-based fertilizers
(C) The incomplete combustion of fossil fuels and biomass

(D) The radioactive decay of radon

228. Match the analytical method to its primary use.
List I: (Method)
P. GC-MS
Q. SEM
R. XRD
S. AAS
List II: (Primary Use)
1. Determining the crystal structure of a solid
2. Quantifying a specific metal in a water sample
3. Imaging the surface morphology of a solid
4. Identifying and quantifying volatile organic compounds
Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-1, S-4

229. A pesticide that is designed to kill fungi is known as a:
(A) Herbicide
(B) Insecticide
(C) Fungicide
(D) Rodenticide

230. The hydrological cycle describes the continuous movement of water:
(A) Only within the oceans.
(B) On, above, and below the surface of the Earth.
(C) Only between the atmosphere and land.
(D) Only in the form of groundwater.

231. Which of the following statements about chemical kinetics is correct?
(A) The rate of reaction is always independent of reactant concentration.
(B) A catalyst increases the activation energy of a reaction.
(C) The order of a reaction is always an integer.
(D) Increasing the temperature generally increases the rate of reaction.

232. Which of the following is NOT an organic component of soil?
(A) Quartz particles
(B) Humus
(C) Living organisms (bacteria, fungi)
(D) Plant roots

233. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Water is often called the universal solvent.
Reason (R) : Its polar nature and ability to form hydrogen bonds allow it to dissolve a wide variety of ionic and polar substances.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

234. In electrophoresis, the rate of migration of a charged particle depends on:
(A) Mass-to-charge ratio and electric field strength.
(B) Its color and odor properties in solution.
(C) Its chemical boiling point only.
(D) Interaction with a stationary phase material.

235. Peroxyacetyl nitrate (PAN), a component of photochemical smog, is an example of a:
(A) Primary pollutant
(B) Natural atmospheric gas
(C) Heavy metal
(D) Secondary pollutant

236. The biochemical toxicity of lead (Pb) arises from its ability to:
(A) Cause rapid oxidation of tissues.
(B) Displace essential metals like calcium and zinc from enzymes.
(C) Absorb UV radiation.
(D) Increase blood oxygen levels.

237. Which of the following processes removes carbon from the atmosphere?
(A) Respiration
(B) Combustion
(C) Photosynthesis
(D) Decomposition

238. What is the primary information obtained from an FTIR spectrum?
(A) The elemental composition of a sample.
(B) The crystal structure of a solid.

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(C) The mass-to-charge ratio of ions.
(D) Chemical bonds and functional groups present.

239. The main environmental issue associated with NOx (oxides of nitrogen) emissions is their role in:
(A) The formation of both acid rain and photochemical smog.
(B) Depleting the stratospheric ozone layer exclusively.
(C) Increasing water salinity.
(D) Causing heavy metal pollution.

240. Consider the following statements about water quality parameters:
1. DO refers to the concentration of O_2 gas dissolved in water.
2. BOD is a measure of the oxygen required by microbes to decompose organic matter.
3. COD is a measure of the oxygen required to chemically oxidize organic matter.
4. For a given polluted water sample, COD is generally higher than BOD.

Which of the above statement(s) is/are correct?
(A) 1 and $_2$ only
(B) 1, 2, and 3 only
(C) 2, 3, and 4 only
(D) 1, 2, 3, and 4

241. A key step in the formation of acid rain is the atmospheric oxidation of:
(A) Carbon monoxide (CO) and methane (CH_4)
(B) Sulfur dioxide (SO_2) and nitrogen oxides (NOx)
(C) Volatile organic compounds (VOCs)
(D) Chlorofluorocarbons (CFCs)

242. In UV-Visible spectrophotometry, the absorbance of a sample is logarithmically related to the:
(A) Transmittance of the sample
(B) Concentration of the sample
(C) Intensity of the incident light
(D) Wavelength of the light

243. The mobility and bioavailability of heavy metals in soil are generally lowest when the soil pH is:
(A) Strongly acidic (pH < 5)
(B) Slightly acidic (pH 6-7)
(C) Neutral to slightly alkaline (pH 7-8.5)
(D) Strongly alkaline (pH > 9)

244. A major biochemical concern with the metalloid Selenium (Se) is that:
(A) It is toxic in all forms and concentrations.
(B) It is a potent carcinogen in any amount.
(C) It bioaccumulates in the same way as mercury.
(D) The window between the essential nutritional requirement and toxic levels is very narrow.

245. Consider the following analytical methods:
1. Atomic Absorption Spectrophotometry (AAS)
2. Inductively Coupled Plasma - Mass Spectrometry (ICP-MS)
3. Fourier-Transform Infrared Spectroscopy (FTIR)
4. Titrimetry
5. X-ray Fluorescence (XRF)

Which of the above statement(s) is/are classified as analytical spectroscopic methods?
(A) 1, 3, and 5 only
(B) 1, 2, 3, and 5 only
(C) 2, 4, and 5 only
(D) All of the above

246. What is the primary function of a monochromator in a spectrophotometer?
(A) To amplify the light signal.
(B) To select a narrow wavelength band of light from a broad-spectrum source.
(C) To hold the sample.
(D) To convert the light signal into an electrical signal.

247. The difference in reactivity between saturated and unsaturated hydrocarbons is primarily due to the:
(A) Difference in their physical states.
(B) Number of hydrogen atoms only.
(C) Saturated hydrocarbons having a higher molecular weight.
(D) Bonds in saturated vs unsaturated ones.

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248. The term redox potential (Eh) is a quantitative measure of the:
(A) Tendency of a system to oxidize or reduce a species.
(B) Acidity of a system.
(C) Solubility of a gas in water.
(D) Heat capacity of a solution.

249. Which statement correctly describes the relationship between Gibbs' energy (ΔG), enthalpy (ΔH), and entropy (ΔS)?
(A) $\Delta H = \Delta G + T\Delta S$
(B) $\Delta S = \Delta G - T\Delta H$
(C) $\Delta G = \Delta H - T\Delta S$
(D) $\Delta G = \Delta S - T\Delta H$

250. Which analytical technique is most suitable for definitive identification of the molecular structure of a pure, complex organic pollutant?
(A) Nuclear Magnetic Resonance (NMR) Spectroscopy
(B) Titrimetry
(C) Flame Photometry
(D) Bomb Calorimetry

Direction : Please read the following source carefully.

The fundamental principles of environmental chemistry govern the fate and transport of chemical species in the environment. Stoichiometry is crucial for quantifying the reactants and products in environmental reactions, such as the neutralization of acid rain or the degradation of organic pollutants. Thermodynamic concepts, particularly Gibbs' energy (ΔG), determine the spontaneity of these processes; a negative ΔG indicates a reaction that can proceed without external energy input. Closely related is chemical potential, which acts as the driving force for mass transfer between different environmental compartments, such as the dissolution of gases from the atmosphere into water bodies. The solubility of gases like oxygen and carbon dioxide in water is a prime example of this principle in action. While thermodynamics predicts whether a reaction is possible, chemical kinetics determines how fast it occurs. Many environmentally significant reactions, though thermodynamically favorable, proceed very slowly without a catalyst. The concept of chemical equilibria is also central, defining the state where the rates of forward and reverse reactions are equal, which is critical for understanding systems like the distribution of a pollutant between water and sediment. The study of unsaturated and saturated hydrocarbons, along with the decay of radioisotopes, further applies these kinetic and equilibrium principles to assess pollutant persistence and dating of environmental samples.

Based on the above source, attempt the following five questions.

251. According to the passage, what is the primary role of Gibbs' energy (ΔG) in environmental chemistry?
(A) To determine the rate at which a chemical reaction occurs.
(B) To indicate the spontaneity of a chemical process.
(C) To quantify the stoichiometric balance of reactants and products.
(D) To measure the concentration of pollutants in a system.

252. Which concept is described as the driving force for the movement of substances between different environmental compartments, such as from air to water?
(A) Chemical potential
(B) Chemical kinetics
(C) Stoichiometric ratio
(D) Gibbs' energy

253. The passage suggests that a chemical reaction that is thermodynamically favorable in the environment will:
(A) always proceed rapidly to completion.
(B) necessarily reach equilibrium very quickly.
(C) not necessarily occur at a fast rate.
(D) require an external input of energy to begin.

254. Based on the text, the study of chemical kinetics is most relevant for understanding which aspect of an environmental reaction?
(A) The final equilibrium concentrations of species.
(B) The quantitative relationship between reactants and products.
(C) The possibility of the reaction occurring spontaneously.
(D) The speed at which the reaction takes place.

255. Which of the following environmental phenomena is presented as a direct application of chemical potential?
(A) The radioactive decay of isotopes in sediment.
(B) The formation of acid rain from precursors.
(C) The dissolution of atmospheric gases in water.

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(D) The neutralization of an acidic lake by a base.

Direction : Please read the following source carefully.

The carbonate system is a cornerstone of aquatic chemistry, fundamentally regulating the pH and buffering capacity of natural waters. This complex equilibrium begins with the dissolution of atmospheric carbon dioxide (CO_2) into water, forming aqueous CO_2(aq). This dissolved CO_2 then hydrates to form carbonic acid (H_2CO_3), a weak acid that subsequently dissociates in a stepwise manner. The first dissociation yields a bicarbonate ion (HCO_3^-) and a hydrogen ion (H^+), and the second dissociation releases another hydrogen ion to form a carbonate ion (CO_3^{2-}). The relative concentrations of these species—CO_2(aq), H_2CO_3, HCO_3^-, and CO_3^{2-}—are highly dependent on the pH of the water. In acidic conditions (low pH), dissolved CO_2 and H_2CO_3 are the dominant forms. In most natural waters with a pH range of 6 to 9, the bicarbonate ion is the most abundant species. In alkaline or high-pH environments, the carbonate ion becomes more significant. This dynamic equilibrium allows the system to resist drastic pH changes; for example, if an acid is introduced, it is neutralized by reacting with bicarbonate and carbonate ions, while the addition of a base is countered by carbonic acid. This buffering mechanism is vital for the survival of aquatic organisms, which are sensitive to pH fluctuations.

Based on the above source, attempt the following five questions.

256. In a typical natural water body with a pH of 7.5, which species from the carbonate system would be the most abundant?
(A) Carbonate ion (CO_3^{2-})
(B) Bicarbonate ion (HCO_3^-)
(C) Carbonic acid (H_2CO_3)
(D) Aqueous carbon dioxide (CO_2(aq))

257. What is the initial step in the formation of the aquatic carbonate system as described in the passage?
(A) The dissociation of carbonic acid into bicarbonate.
(B) The formation of carbonate ions from bicarbonate.
(C) The hydration of bicarbonate ions in alkaline water.
(D) The dissolution of atmospheric CO_2 into water.

258. According to the passage, the primary function of the carbonate system in natural waters is to:
(A) regulate and buffer the water's pH.
(B) increase the solubility of atmospheric gases.
(C) act as a primary source of nutrients for algae.
(D) precipitate heavy metals from the water column.

259. If a water body experiences an influx of acidic pollutants, which component of the carbonate system would primarily react to neutralize the acid?
(A) Aqueous carbon dioxide (CO_2(aq))
(B) Carbonic acid (H_2CO_3)
(C) Bicarbonate and carbonate ions
(D) Hydrogen ions (H^+)

260. The relative distribution of the different species in the carbonate system is described as being most dependent on which factor?
(A) Water pH
(B) Water temperature
(C) Atmospheric pressure
(D) Dissolved oxygen levels

Direction : Please read the following source carefully.

The Earth's atmosphere is a complex mixture whose composition is dominated by nitrogen and oxygen, but also contains trace amounts of particles, ions, and radicals that play a disproportionately large role in atmospheric chemistry. Chemical speciation, the distribution of an element among defined chemical species, is critical to understanding the reactivity, transport, and toxicity of substances in the air. The formation of particulate matter, both inorganic and organic, is a key atmospheric process driven by thermochemical and photochemical reactions. Inorganic particulates can be formed through gas-to-particle conversion, where gases like sulfur dioxide (SO_2) and nitrogen oxides (NOx) are oxidized in the atmosphere to form sulfuric acid (H_2SO_4) and nitric acid (HNO_3). These acids can then react with ammonia (NH_3) to form

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ammonium sulfate and ammonium nitrate salts, which exist as fine particles. Organic particulate matter is formed from the atmospheric oxidation of volatile organic compounds (VOCs), creating low-volatility products that condense to form secondary organic aerosols (SOA). Photochemical reactions, initiated by solar radiation, are particularly important in creating the highly reactive radicals (like the hydroxyl radical, •OH) that drive these oxidation processes during the day. Thermochemical reactions, which do not require light, can continue these processes at night.

Based on the above source, attempt the following five questions.

261. According to the passage, what is the significance of chemical speciation in the atmosphere?
(A) It determines the total mass of pollutants present in the air.
(B) It defines the elemental composition of the major atmospheric gases.
(C) It is a measure of the total number of particles, ions, and radicals.
(D) It helps understand the reactivity and transport of airborne substances.

262. The formation of ammonium sulfate and ammonium nitrate particles in the atmosphere is an example of:
(A) a reaction primarily involving organic compounds.
(B) a gas-to-particle conversion process for inorganic matter.
(C) the formation of secondary organic aerosols.
(D) the direct emission of primary particulate matter.

263. Which of the following is identified as a key driver for the daytime oxidation of atmospheric pollutants?
(A) Thermochemical reactions occurring in the absence of light.
(B) The direct interaction between inorganic and organic particles.
(C) Photochemical reactions initiated by solar radiation.
(D) The condensation of high-volatility organic compounds.

264. The passage indicates that secondary organic aerosols (SOA) are formed through which process?
(A) The direct emission from combustion sources.
(B) The reaction of nitric acid with ammonia.
(C) The photochemical breakdown of the ozone layer.
(D) The atmospheric oxidation of volatile organic compounds.

265. What role do radicals like the hydroxyl radical (•OH) play in the atmosphere, according to the text?
(A) They are highly reactive species that drive oxidation processes.
(B) They act as stable end-products of atmospheric pollution.
(C) They are the primary components of inorganic particulate matter.
(D) They primarily absorb solar radiation, heating the atmosphere.

Direction : Please read the following source carefully.

Atmospheric chemistry is significantly influenced by reactions involving oxygen and ozone. In the stratosphere, a dynamic equilibrium known as the Chapman cycle describes the formation and destruction of ozone (O_3). This process begins with the photodissociation of molecular oxygen (O_2) by high-energy ultraviolet (UV) radiation (wavelength < 242 nm) to produce two oxygen atoms (O). Each of these reactive atoms can then combine with another oxygen molecule to form ozone. Ozone itself is photochemically active and can be dissociated by absorbing UV radiation of a longer wavelength, regenerating an oxygen molecule and an oxygen atom. This cycle of ozone formation and destruction is a crucial natural shield, absorbing the majority of harmful solar UV radiation. In contrast, ozone in the troposphere is considered a pollutant and is a primary constituent of photochemical smog. Its formation is not a simple oxygen-only process but a complex series of photochemical reactions involving nitrogen oxides (NOx) and volatile organic compounds (VOCs). In this cycle, sunlight provides the energy to initiate reactions that oxidize VOCs and NOx, leading to the net production of ozone. Therefore, while stratospheric ozone is

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beneficial, tropospheric ozone is detrimental to human health and ecosystems.

Based on the above source, attempt the following five questions.

266. According to the Chapman cycle described in the passage, what is the initial step for ozone formation in the stratosphere?
(A) The reaction of an oxygen atom with an oxygen molecule.
(B) The photodissociation of molecular oxygen by UV radiation.
(C) The photodissociation of ozone by UV radiation.
(D) The combination of two ozone molecules to form oxygen.

267. The passage highlights a significant difference between stratospheric and tropospheric ozone. What is this key distinction?
(A) Stratospheric ozone is formed by NOx and VOCs, while tropospheric ozone is formed from pure oxygen.
(B) Stratospheric ozone is beneficial by absorbing UV, while tropospheric ozone is a pollutant.
(C) Stratospheric ozone is destroyed by sunlight, while tropospheric ozone is stable in sunlight.
(D) Stratospheric ozone exists as O_2, while tropospheric ozone exists as O_3.

268. What is the role of nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the context of atmospheric ozone?
(A) They act as catalysts in the photochemical formation of tropospheric ozone.
(B) They are essential for the formation of the protective stratospheric ozone layer.
(C) They primarily function to destroy both stratospheric and tropospheric ozone.
(D) They absorb UV radiation more effectively than stratospheric ozone.

269. The absorption of harmful solar UV radiation is described as a direct consequence of which process?
(A) The formation of tropospheric smog.
(B) The reaction between NOx and VOCs.
(C) The cycle of ozone formation and destruction in the stratosphere.
(D) The photodissociation of nitrogen oxides in the lower atmosphere.

270. Photochemical smog is mentioned as being primarily constituted by which substance?
(A) Molecular oxygen
(B) Stratospheric ozone
(C) Nitrogen oxides
(D) Tropospheric ozone

Direction : Please read the following source carefully.

The hydrological cycle describes the continuous movement of water on, above, and below the surface of the Earth. Within this cycle, water's role as a universal solvent is paramount, as it dissolves a vast array of minerals, nutrients, and pollutants. The quality of natural water bodies is often assessed using several key chemical parameters. The concept of Dissolved Oxygen (DO) refers to the concentration of molecular oxygen dissolved in water, which is essential for the respiration of most aquatic organisms. A sharp decrease in DO can indicate pollution. Biochemical Oxygen Demand (BOD) is a measure of the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at a certain temperature over a specific time period. It serves as an indirect measure of the concentration of biodegradable organic pollution. In contrast, Chemical Oxygen Demand (COD) provides a broader measure of pollution. COD is the amount of oxygen required to chemically oxidize both biodegradable and non-biodegradable organic matter in water using a strong oxidizing agent. Consequently, for a given water sample, the COD value is typically higher than the BOD value, as it accounts for a wider range of organic substances.

Based on the above source, attempt the following five questions.

271. What fundamental property of water is highlighted as being paramount to its role in the hydrological cycle?
(A) Its ability to exist in three physical states.
(B) Its high specific heat capacity.
(C) Its capacity as a universal solvent.
(D) Its neutral pH in pure form.

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272. According to the passage, what does Biochemical Oxygen Demand (BOD) indirectly measure?
(A) The concentration of all organic matter in a water sample.
(B) The concentration of biodegradable organic pollution.
(C) The amount of dissolved oxygen available for aquatic life.
(D) The quantity of non-biodegradable pollutants.

273. Which statement accurately reflects the relationship between BOD and COD for the same polluted water sample?
(A) The BOD value is always equal to the COD value.
(B) The BOD value is generally higher than the COD value.
(C) There is no consistent relationship between BOD and COD values.
(D) The COD value is typically higher than the BOD value.

274. A significant and sudden decrease in the Dissolved Oxygen (DO) level in a river most likely indicates:
(A) the introduction of oxygen-demanding pollutants.
(B) an increase in water temperature.
(C) the presence of an active photosynthetic algal bloom.
(D) a decrease in atmospheric pressure.

275. The key difference between the pollutants measured by BOD and COD is that:
(A) BOD measures only inorganic pollutants while COD measures organic ones.
(B) BOD is a measure of chemical oxidation, whereas COD is a measure of biological oxidation.
(C) COD measures both biodegradable and non-biodegradable organics, while BOD measures mainly biodegradable organics.
(D) COD is relevant only for industrial wastewater, while BOD is for natural waters.

Direction : Please read the following source carefully.

Water purification involves several physical and chemical processes designed to remove suspended solids, pathogens, and other impurities. The initial stages often rely on physical separation based on density and particle size. Sedimentation is a process where gravity is used to settle heavier suspended particles out of the water. To enhance the removal of very fine and colloidal particles that do not settle easily, chemical treatment is employed. Coagulation involves adding a chemical, such as alum or ferric chloride, which neutralizes the negative charges on colloidal particles, allowing them to clump together. This is immediately followed by flocculation, a process of gentle mixing that encourages these destabilized particles to aggregate into larger, visible flocs. These larger and heavier flocs can then be removed more effectively by subsequent sedimentation or filtration. Filtration provides a physical barrier to remove the remaining suspended particles, including the flocs. The efficiency of these processes, particularly coagulation, is highly dependent on chemical conditions, with pH being a critical control parameter. Furthermore, the overall chemical state of an aquatic system, including its potential for oxidation or reduction reactions, is described by its Redox potential (Eh). A high Eh indicates oxidizing conditions, while a low Eh signifies reducing conditions, which can influence the speciation and solubility of many elements in water.

Based on the above source, attempt the following five questions.

276. What is the primary purpose of adding chemicals like alum during the coagulation step of water treatment?
(A) To neutralize the charge on colloidal particles.
(B) To disinfect the water by killing pathogens.
(C) To adjust the final pH of the treated water.
(D) To directly filter out dissolved impurities.

277. The process of gently mixing water to encourage destabilized particles to aggregate into larger flocs is known as:
(A) Sedimentation
(B) Coagulation
(C) Filtration
(D) Flocculation

278. According to the passage, the Redox potential (Eh) of a water body provides information about its:

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(A) temperature and pressure conditions.
(B) potential for oxidation or reduction reactions.
(C) total suspended solids concentration.
(D) acidity or alkalinity.

279. Which sequence correctly represents the order of processes used to remove fine suspended particles?
(A) Flocculation → Filtration → Coagulation
(B) Sedimentation → Flocculation → Coagulation
(C) Coagulation → Flocculation → Filtration
(D) Filtration → Coagulation → Sedimentation

280. A water system with a low Eh value would be characterized as having:
(A) highly oxidizing conditions.
(B) neutral chemical conditions.
(C) a high concentration of dissolved oxygen.
(D) highly reducing conditions.

Direction : Please read the following source carefully.

Soil is a complex, dynamic system composed of both inorganic and organic components, which together support terrestrial life. The inorganic fraction originates from the weathering of parent rock and consists of minerals like quartz, feldspars, and clays, providing a structural framework and a reservoir of essential nutrients. The organic component, known as soil organic matter (SOM), is derived from the decomposition of plant and animal residues. It plays a vital role in improving soil structure, water retention, and nutrient availability. The cycling of elements through the soil and other environmental compartments is described by biogeochemical cycles. The nitrogen cycle is particularly complex, involving processes such as nitrogen fixation (conversion of atmospheric N_2 to ammonia), nitrification (oxidation of ammonia to nitrate), and denitrification (reduction of nitrate back to N_2 gas), all mediated by microorganisms. The carbon cycle in soils involves the balance between carbon inputs from photosynthesis and plant litter, and carbon losses through decomposition and respiration by soil organisms. This balance determines whether a soil acts as a source or a sink for atmospheric carbon dioxide. Similarly, the phosphorus and sulphur cycles involve the transformation of these elements between various organic and inorganic forms, controlling their availability to plants and other organisms.

Based on the above source, attempt the following five questions.

281. What is the origin of the inorganic components of soil as described in the passage?
(A) The weathering of parent rock material.
(B) The decomposition of plant and animal matter.
(C) The fixation of atmospheric nitrogen by bacteria.
(D) The precipitation of minerals from rainwater.

282. The process in the nitrogen cycle that involves the reduction of nitrate back into gaseous nitrogen (N_2) is called:
(A) Nitrification
(B) Denitrification
(C) Nitrogen fixation
(D) Ammonification

283. According to the text, what is the primary role of soil organic matter (SOM)?
(A) To form the primary structural framework of the soil.
(B) To improve soil structure, water retention, and nutrient supply.
(C) To directly convert atmospheric N_2 to ammonia.
(D) To consist solely of inorganic minerals like quartz and clays.

284. The balance between carbon inputs from photosynthesis and losses from decomposition determines which important soil function related to the carbon cycle?
(A) Whether the soil acts as a source or sink for atmospheric CO_2.
(B) The rate of nitrification in the soil profile.
(C) The availability of phosphorus for plant uptake.
(D) The speed at which parent rock weathers.

285. The transformation of ammonia to nitrate in the soil is a key step in the nitrogen cycle known as:
(A) Denitrification
(B) Nitrogen fixation
(C) Nitrification

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(D) Photosynthesis

Direction : Please read the following source carefully.

The environment is increasingly burdened by toxic chemicals, which can be broadly categorized based on their structure and effects. Pesticides are one such group, classified according to their target organisms (e.g., insecticides, herbicides, fungicides) or chemical structure. Their effects can be far-reaching, from acute toxicity to chronic impacts like endocrine disruption and bioaccumulation through the food web. Another significant group of toxic substances includes heavy metals and metalloids. The biochemical aspects of their toxicity are of particular concern. For instance, mercury (Hg) can be biomagnified in aquatic systems as methylmercury, a potent neurotoxin. Cadmium (Cd) often accumulates in the kidneys and can cause skeletal damage, while lead (Pb) famously interferes with the nervous system, particularly in children, by disrupting enzyme functions. Chromium (Cr), especially in its hexavalent form (Cr(VI)), is a known carcinogen. The metalloid arsenic (As) can interfere with cellular energy production and is associated with various cancers. Selenium (Se), while an essential micronutrient at low concentrations, becomes toxic at higher levels, demonstrating the dose-dependent nature of chemical toxicity. These elements exert their harmful effects by binding to essential biological molecules like proteins and enzymes, disrupting their structure and function.

Based on the above source, attempt the following five questions.

286. According to the passage, the biochemical toxicity of heavy metals like lead and mercury is often due to their ability to:
(A) act as essential micronutrients in all concentrations.
(B) be easily broken down by biological organisms.
(C) rapidly decay into non-toxic elements in the environment.
(D) bind to and disrupt the function of proteins and enzymes.

287. Which substance is specifically mentioned as a potent neurotoxin that biomagnifies in aquatic food webs?
(A) Hexavalent chromium (Cr(VI))
(B) Cadmium (Cd)
(C) Methylmercury
(D) Selenium (Se)

288. The passage states that hexavalent chromium (Cr(VI)) is known primarily for its:
(A) beneficial role as a micronutrient.
(B) carcinogenic properties.
(C) neurotoxic effects on children.
(D) accumulation in skeletal tissue.

289. The example of Selenium (Se) is used in the text to illustrate which toxicological principle?
(A) All metalloids are exclusively toxic to living organisms.
(B) Heavy metals only affect the nervous system.
(C) Pesticides and heavy metals have identical effects.
(D) The toxicity of a chemical can be dose-dependent.

290. Which heavy metal is described as accumulating in the kidneys and potentially causing skeletal damage?
(A) Cadmium (Cd)
(B) Lead (Pb)
(C) Mercury (Hg)
(D) Arsenic (As)

Direction : Please read the following source carefully.

The air we breathe can contain a variety of toxic chemicals that pose significant risks to human health and the environment. These pollutants include primary gases like carbon monoxide (CO), a toxic gas resulting from incomplete combustion that impairs oxygen transport in the blood. Ozone (O_3), when present in the troposphere, is a powerful oxidant that damages respiratory tissues. A key component of photochemical smog is Peroxyacetyl Nitrate (PAN), which is a potent eye irritant and phytotoxicant. Volatile Organic Compounds (VOCs) are a broad class of carbon-based chemicals that evaporate easily at room temperature; many are direct irritants or toxins, and they also act as precursors to the formation of secondary pollutants like ozone and PAN. Another critical group is Persistent Organic Pollutants (POPs), which are chemicals that resist degradation, bioaccumulate in fatty

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tissues, and can be transported long distances. Their persistence makes them a long-term global threat. Furthermore, the presence of carcinogens in the air is a major public health concern. These are substances capable of causing cancer in living tissue. Carcinogenic compounds can be found in vehicle exhaust, industrial emissions, and tobacco smoke, and may include specific VOCs like benzene or polycyclic aromatic hydrocarbons (PAHs) adsorbed onto particulate matter.

Based on the above source, attempt the following five questions.

291. What is the primary toxic action of carbon monoxide (CO) as described in the passage?
(A) It acts as a precursor for ozone formation.
(B) It causes eye irritation and plant damage.
(C) It impairs the transport of oxygen in the blood.
(D) It bioaccumulates in the fatty tissues of organisms.

292. Persistent Organic Pollutants (POPs) are characterized by which set of properties?
(A) Resistance to degradation, bioaccumulation, and long-range transport.
(B) Rapid evaporation, high reactivity, and short-term effects.
(C) Water solubility, many are biodegradable, and localized impact.
(D) Gaseous state, direct emission, and primary role in smog formation.

293. According to the text, which pollutant is specifically identified as a potent eye irritant and a component of photochemical smog?
(A) Carbon monoxide (CO)
(B) A persistent organic pollutant (POP)
(C) Carbon dioxide (CO_2)
(D) Peroxyacetyl Nitrate (PAN)

294. The passage describes Volatile Organic Compounds (VOCs) as having a dual role in air pollution. What is this dual role?
(A) Acting as both a primary nutrient and a secondary toxin.
(B) Being directly toxic and acting as precursors to secondary pollutants.
(C) Being both solid particulates and gaseous pollutants.
(D) Causing both global warming and ozone layer depletion.

295. A substance in the air that is capable of causing cancer, such as benzene or a PAH, is classified as a:
(A) Persistent Organic Pollutant (POP).
(B) Volatile Organic Compound (VOC).
(C) Carcinogen.
(D) Peroxyacetyl Nitrate (PAN).

Direction : Please read the following source carefully.

The analysis of environmental samples requires a diverse array of analytical methods, each based on specific scientific principles. Classical techniques like Titrimetry and Gravimetry offer quantitative analysis based on reaction stoichiometry and mass measurement, respectively. Bomb Calorimetry measures the heat of combustion to determine the energy content of a sample. Chromatography is a powerful separation technique based on the differential partitioning of analytes between a stationary phase and a mobile phase; variations include Paper Chromatography, Thin-Layer Chromatography (TLC), Gas Chromatography (GC), and High-Performance Liquid Chromatography (HPLC). Spectrophotometric methods are based on the interaction of electromagnetic radiation with matter. This includes UV-Visible Spectrophotometry (UV-VIS) for electronic transitions, and Flame Photometry and Atomic Absorption Spectrophotometry (AAS) for quantifying elements based on their characteristic light emission or absorption. More advanced atomic spectrometry techniques like Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) and ICP-Mass Spectrometry (ICP-MS) offer multi-element analysis at very low concentrations. For structural and functional group identification, Fourier-Transform Infrared Spectroscopy (FTIR) and Nuclear Magnetic Resonance (NMR) are employed. Hyphenated techniques like Gas Chromatography-Mass Spectrometry (GC-MS) combine separation with detection for definitive identification. Lastly, techniques like X-ray Fluorescence (XRF), X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM) provide information on elemental composition, crystalline structure, and surface morphology.

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Based on the above source, attempt the following five questions.

296. What is the fundamental principle behind chromatographic techniques like GC and HPLC?
(A) The measurement of heat released during a combustion reaction.
(B) The measurement of mass of a precipitate formed in a chemical reaction.
(C) The interaction of X-rays with the crystalline structure of a sample.
(D) The separation of analytes based on their differential partitioning between two phases.

297. A researcher wants to identify the functional groups present in an unknown organic pollutant. According to the passage, which technique would be most suitable for this purpose?
(A) Fourier-Transform Infrared Spectroscopy (FTIR)
(B) Atomic Absorption Spectrophotometry (AAS)
(C) Bomb Calorimetry
(D) Gravimetry

298. The group of techniques including UV-VIS, AAS, and ICP-AES are all based on which common principle?
(A) The separation of components based on volatility.
(B) The interaction of electromagnetic radiation with matter.
(C) The measurement of mass-to-charge ratios of ions.
(D) The measurement of heat change in a closed system.

299. What is the primary advantage of a hyphenated technique like Gas Chromatography-Mass Spectrometry (GC-MS)?
(A) It provides information on surface morphology at a microscopic level.
(B) It combines a separation method with a detection method for definitive identification.
(C) It determines the crystalline structure of a solid sample.
(D) It measures the total energy content of a sample with high precision.

300. If an analyst needs to determine the surface morphology and elemental composition of a particulate matter sample, which pair of techniques would be appropriate?
(A) SEM and XRF
(B) Titrimetry and Bomb Calorimetry
(C) NMR and Paper Chromatography
(D) HPLC and UV-VIS

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ANSWERS

1. (B) The quantitative relationship between reactants and products.
Stoichiometry focuses on the quantitative relationships between the amounts of reactants used and the products formed in a chemical reaction. It relies on the law of conservation of mass, where the total mass of reactants equals the total mass of products. By using balanced chemical equations, scientists calculate the precise proportions and yields required for specific environmental processes and laboratory experiments to ensure chemical efficiency and safety.

2. (A) Its molecular polarity and ability to form hydrogen bonds.
Water is frequently called the universal solvent because its polar molecular structure allows it to dissolve a wide range of substances. Each water molecule has a partial positive charge on the hydrogen atoms and a partial negative charge on the oxygen atom. This polarity, combined with the ability to form strong hydrogen bonds, enables water to attract and surround ions and polar molecules effectively in diverse environments.

3. (C) The COD value is typically lower than the BOD value for the same water sample.
Chemical Oxygen Demand represents the total amount of oxygen required to chemically oxidize all organic matter in a water sample. This measurement includes both biodegradable and non-biodegradable substances. Consequently, the value obtained from a chemical oxygen demand test is almost always higher than the biochemical oxygen demand, as the latter only measures the oxygen used by microorganisms to decompose the biodegradable fraction of organic pollutants present.

4. (D) To act as highly reactive atmospheric chemical intermediates.
Radicals are atoms or molecules containing one or more unpaired electrons, making them extremely reactive. In the atmosphere, these species serve as critical chemical intermediates that drive most oxidative processes. They initiate complex reaction chains by attacking stable molecules, leading to the transformation and removal of various pollutants. Their high reactivity ensures that they exist only briefly before participating in subsequent chemical steps within the lower troposphere.

5. (A) P-4, Q-1, R-2, S-3
Analytical chemistry utilizes various methods to measure physical and chemical properties. Titrimetry involves determining the volume of a solution of known concentration, while gravimetry focuses on measuring the mass of a substance. Bomb calorimetry is specifically designed to measure the heat released during combustion at constant volume. Flame photometry quantifies the intensity of light emitted when an element is introduced into a flame for elemental analysis and identification.

6. (B) Clay minerals
Soil is a complex mixture consisting of both organic and inorganic materials. Inorganic components are primarily derived from the weathering of parent rocks and include various minerals. Clay minerals represent a significant part of this inorganic fraction, contributing to the chemical and physical properties of the soil. Unlike humus, bacteria, and fungi, which constitute the organic and biological parts, these minerals provide structural stability and nutrient-holding capacity.

7. (D) The reaction is spontaneous under the given conditions.
Gibbs free energy is a thermodynamic potential used to predict the direction of chemical processes under constant temperature and pressure. When the change in Gibbs energy is negative, it indicates that the reaction can proceed without any external energy input. Such reactions are termed spontaneous, meaning they are thermodynamically favorable. This value does not provide information about the reaction rate, only the thermodynamic potential for occurrence.

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8. (A) The dissolved oxygen required by aerobic organisms to decompose organic matter.
Biochemical oxygen demand is a critical water quality parameter reflecting the amount of dissolved oxygen consumed by aerobic microorganisms. These organisms use oxygen while breaking down organic matter present in an aquatic environment over a specific period. High values indicate significant organic pollution, which can deplete dissolved oxygen levels and harm aquatic life. This test provides essential data for managing wastewater treatment and assessing ecosystem health.

9. (C) Volatile Organic Compounds (VOCs)
Volatile organic compounds are organic chemicals with high vapor pressure at room temperature. While many are not primary greenhouse gases, they play a vital role in atmospheric chemistry by serving as precursors to photochemical smog. These compounds react with nitrogen oxides in the presence of sunlight to produce ground-level ozone and other secondary pollutants. Their presence significantly impacts urban air quality and human respiratory health globally.

10. (A) Both A and R are true and R is the correct explanation of A.
Natural rainwater is inherently slightly acidic due to its interaction with the atmosphere. Carbon dioxide gas dissolves into falling raindrops, reacting with water molecules to form carbonic acid, which is a weak acid. This chemical process naturally lowers the pH of pristine rainwater to approximately five point six. Consequently, any measurement significantly below this value indicates the presence of additional acidic pollutants like sulfur or nitrogen oxides.

11. (D) The distribution of an element among defined chemical species.
Chemical speciation refers to the identification and quantification of the different chemical and physical forms of an element within a system. This concept is vital because the toxicity, mobility, and bioavailability of an element often depend on its specific form rather than its total concentration. For instance, different oxidation states or complexed forms of the same metal can exhibit vastly different environmental behaviors and health impacts.

12. (A) Both Statement I and Statement II are true.
Hydrocarbons are classified based on the nature of the bonds between carbon atoms. Saturated hydrocarbons, known as alkanes, contain only single covalent bonds, leading to a maximum number of hydrogen atoms per carbon. In contrast, unsaturated hydrocarbons include alkenes and alkynes, which possess at least one double or triple bond, respectively. This structural difference significantly influences their chemical reactivity and physical properties in various urban and industrial environments.

13. (C) Coagulation
Coagulation is a fundamental process in water treatment used to remove small, suspended particles that do not settle easily. By adding specific chemical agents, the electrical charges on these colloidal particles are neutralized, allowing them to clump together into larger aggregates. This step is essential before flocculation and sedimentation, as it facilitates the removal of impurities that otherwise contribute to turbidity and carry diverse pollutants.

14. (D) It increases the reaction rate without being consumed.
A catalyst is a substance that increases the speed of a chemical reaction by providing an alternative pathway with a lower activation energy. It remains chemically unchanged and is not consumed during the overall process. While it accelerates the rate at which equilibrium is reached, it does not alter the position of the equilibrium or the total Gibbs free energy change associated with the chemical transformation.

15. (C) 1, 2 and 3 only
Pesticides encompass a variety of chemicals designed to manage or eliminate organisms considered pests. Organochlorines are a specific group noted for their extreme environmental persistence and tendency to accumulate in food chains. Herbicides are a subset of pesticides targeted specifically at controlling unwanted vegetation or weeds. While many pesticides are synthetic, some naturally occurring substances also possess pesticidal properties, used widely in agricultural and residential pest management settings.

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16. (B) The tendency of a species to acquire electrons and be reduced.
Redox potential, often denoted as Eh, serves as a quantitative measure of the tendency of a chemical species to acquire electrons and thereby be reduced. In environmental systems, it indicates the oxidizing or reducing power of the environment. High positive values suggest an oxidizing atmosphere where oxygen or nitrates are prevalent, while negative values indicate a reducing environment typical of anaerobic conditions in waterlogged sediments.

17. (B) Cadmium (Cd)
Itai-itai disease is a severe condition characterized by painful bone softening and kidney failure caused by chronic cadmium poisoning. This environmental tragedy occurred in Japan due to the release of cadmium into rivers by mining companies. The contaminated water was used for irrigating rice fields, leading to the bioaccumulation of the toxic metal in the local food supply. It highlights the dangers of industrial pollution.

18. (A) Reduction
In the biogeochemical sulfur cycle, the conversion of sulfate ions to hydrogen sulfide under anaerobic conditions is a reduction process. This transformation is primarily carried out by specialized bacteria that use sulfate as an electron acceptor during the decomposition of organic matter in oxygen-depleted environments like wetlands or deep sediments. This process is a critical step in recycling sulfur and influences the acidity and toxicity.

19. (C) Decreases as the temperature of the water increases.
The solubility of gases in water is significantly influenced by environmental conditions, particularly temperature. As the temperature of a water body increases, the kinetic energy of the dissolved gas molecules also rises, making them more likely to escape into the atmosphere. Consequently, warmer water holds less dissolved oxygen and other gases compared to cooler water. This relationship is crucial for aquatic life during seasonal temperature changes.

20. (A) 1, 3, and 5 only
Atmospheric particles, or aerosols, originate from both natural and human activities, including volcanic eruptions and industrial emissions. These particles are essential for cloud formation as they act as condensation nuclei for water vapor. Furthermore, they significantly impact the Earth's radiation balance by scattering or absorbing incoming solar energy. They consist of a diverse mix of organic and inorganic substances, varying in size, shape, and chemistry.

21. (C) Photochemical smog
Peroxyacetyl nitrate is a powerful secondary pollutant and a characteristic component of photochemical smog. It forms through complex reactions between volatile organic compounds and nitrogen oxides in the presence of sunlight. This compound is known for its stability at low temperatures, allowing it to be transported over long distances. It is highly irritating to the eyes and respiratory system and can cause significant damage to crops.

22. (B) Chromatography
Chromatography is a versatile analytical technique used to separate the individual components of a mixture based on their unique physical and chemical properties. The process involves a mobile phase, which carries the sample, moving through a stationary phase. Different substances travel at different rates because of their varying affinities for these two phases. This differential migration allows for the effective isolation and identification of complex pollutants.

23. (D) An atom with an unstable nucleus undergoing radioactive decay.
A radioisotope is an atom that possesses an unstable nucleus, characterized by an imbalance between protons and neutrons. To reach a more stable state, the nucleus undergoes spontaneous radioactive decay by emitting radiation in the form of particles or electromagnetic waves. This process continues until a stable isotope is formed. Radioisotopes are used in diverse fields, including medical diagnostics, industrial tracing, and the radiometric dating of materials.

24. (A) Carbonate ion (CO3^2-)
The distribution of chemical species within the carbonate system of water is highly dependent

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on the pH level. In highly alkaline environments where the pH exceeds ten point three, the carbonate ion becomes the predominant species. At lower pH levels, other forms such as bicarbonate or dissolved carbon dioxide and carbonic acid are more common. Understanding these transitions is essential for studying the buffering capacity.

25. (A) 1, 2, 3, 4
The hydrological cycle describes the continuous movement of water throughout the Earth's systems. Starting from surface water, the process begins with evaporation driven by solar energy. As water vapor rises and cools, it undergoes condensation to form clouds. This eventually leads to precipitation in the form of rain or snow. Once on the ground, water can follow various paths, including infiltration into the soil.

26. (A) Propene (C3H6)
Unsaturated hydrocarbons are organic compounds that contain at least one double or triple covalent bond between carbon atoms. Propene is a prime example of an alkene, featuring a carbon-carbon double bond within its molecular structure. Unlike saturated hydrocarbons like methane, ethane, and butane, which only contain single bonds, propene is more chemically reactive. This reactivity allows it to participate easily in diverse chemical addition reactions.

27. (D) Reaction of atomic oxygen with molecular oxygen ($O + O_2 \longrightarrow O_3$).
The formation of ozone in the stratosphere is a natural process initiated by high-energy solar ultraviolet radiation. When UV light strikes a molecular oxygen molecule, it can cause photodissociation, splitting the molecule into two individual oxygen atoms. These highly reactive atomic oxygens then quickly combine with other available oxygen molecules in the presence of a third body to form ozone. This cycle is crucial.

28. (B) P-4, Q-1, R-3, S-2
Different toxic substances are classified according to their chemical nature and biological effects. Benzene is a volatile organic compound known for its carcinogenic properties, while DDT is a notorious organochlorine pesticide characterized by environmental persistence. Cadmium is a toxic heavy metal that can cause severe health issues through bioaccumulation. Carbon monoxide acts as a chemical asphyxiant by binding to hemoglobin, reducing the oxygen-carrying capacity.

29. (C) The change in Gibbs' energy per mole of the component added.
Chemical potential is a fundamental thermodynamic property that represents the change in the Gibbs free energy of a system when an additional mole of a specific component is added, keeping temperature and pressure constant. It serves as a measure of the chemical energy available to drive processes like reactions, diffusion, or phase transitions. Systems naturally move from regions of high to low potential until equilibrium.

30. (D) Ammonification (Mineralization)
Ammonification, also known as mineralization, is a vital step in the nitrogen cycle where microorganisms break down organic nitrogenous matter. This process involves the conversion of complex organic molecules from dead plants and animals into simpler inorganic ammonium ions. This transformation makes nitrogen available again for further microbial processes like nitrification or direct uptake by plants. It is essential for recycling nutrients within ecosystems.

31. (A) X-ray Fluorescence (XRF)
X-ray fluorescence is a powerful analytical technique used to determine the elemental composition of materials. When a sample is irradiated with high-energy X-rays, the atoms become excited and emit characteristic X-rays as they return to a lower energy state. By measuring the energy and intensity of these emitted rays, scientists can identify and quantify the elements present. This method is non-destructive and widely used.

32. (B) Nitrification
Conventional water treatment focuses on removing suspended solids and pathogens to produce safe drinking water. Common steps include coagulation to destabilize particles, flocculation to form larger clumps, and filtration to remove those aggregates. Nitrification, however, is a biological process typically used in

wastewater treatment to convert ammonia into nitrates. It is not a standard part of the primary treatment sequence used to purify water.

33. (A) Both A and R are true and R is the correct explanation of A.
Photochemical smog is a complex mixture of air pollutants whose formation is triggered by solar radiation. The primary initiating step involves the absorption of ultraviolet light by nitrogen dioxide molecules, leading to their photolysis. This reaction produces nitric oxide and a highly reactive oxygen atom. This individual oxygen atom then quickly reacts with molecular oxygen to form ground-level ozone, starting harmful secondary pollution chains.

34. (A) Environmental stability, bioaccumulation, and long-range transport.
Persistent organic pollutants are a group of toxic chemicals characterized by several specific traits. These substances are highly resistant to environmental degradation, allowing them to persist for long periods in soil, water, and air. They are also lipophilic, meaning they easily accumulate in the fatty tissues of living organisms. Furthermore, their stability and volatility enable them to undergo long-range atmospheric transport, reaching remote regions far away.

35. (C) Gentle mixing to promote agglomeration of particles into flocs.
Flocculation is a physical process in water treatment that follows the chemical stage of coagulation. It involves the gentle and slow mixing of water to encourage small, destabilized particles to collide and stick together. This interaction leads to the formation of larger, heavier aggregates known as flocs. These flocs are then much easier to remove during subsequent sedimentation and filtration steps, effectively reducing turbidity.

36. (D) It measures light absorbed by ground-state atoms in a vapor.
Atomic absorption spectrophotometry is an analytical technique used to measure the concentration of specific metallic elements. The principle relies on the fact that ground-state atoms in a vapor phase absorb light at very specific wavelengths corresponding to their unique electronic transitions. By measuring the amount of light absorbed from a specialized lamp, the concentration of the element in the sample can be determined. It is sensitive.

37. (C) Lacks a significant gaseous component in the atmosphere.
The phosphorus cycle is distinct from other major biogeochemical cycles, such as the nitrogen and carbon cycles, because it lacks a significant gaseous phase in the atmosphere. Phosphorus primarily moves through the lithosphere, hydrosphere, and biosphere in the form of phosphate ions. Since it does not exist as a common gas under typical environmental conditions, its movement is much slower and depends on weathering.

38. (B) Sulfhydryl (-SH) groups in enzymes and proteins.
The toxic effects of mercury in biological systems are largely attributed to its strong chemical affinity for sulfur. Specifically, mercury atoms bind readily to sulfhydryl groups found within the structure of many enzymes and proteins. This binding can disrupt the normal functioning of these molecules, leading to cellular damage and the failure of critical metabolic pathways. This mechanism explains why mercury exposure primarily affects nerves.

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39. (D) Systems shift to relieve stress from applied changes in condition.
Le Chatelier's principle is a fundamental concept in chemical equilibria that describes how a system at equilibrium responds to external changes. If a change in concentration, temperature, or pressure is applied to a system, the equilibrium position will shift in a direction that tends to counteract or relieve the imposed stress. This principle allows scientists to predict how varying environmental conditions will influence chemical species.

40. (A) 1, 2 and 4 only
The Earth's atmosphere is composed of a mixture of gases with varying abundances. Nitrogen and oxygen are the most prevalent, together making up approximately ninety-nine percent of dry air. Argon is the third most abundant gas, while carbon dioxide, though present in trace amounts, has a profound impact on the global climate. In contrast, the concentration of water vapor is

highly variable, depending on local geographic conditions.

41. (C) To measure the heat of combustion of a substance.
A bomb calorimeter is a specialized instrument used in thermodynamics to determine the heat of combustion of a substance. The measurement is performed by burning a sample in a high-pressure oxygen environment within a strong, constant-volume container. The heat released during the reaction is transferred to a surrounding water bath, where the resulting temperature change is precisely measured. This data is essential for calculating energy content.

42. (A) Both Statement I and Statement II are true.
Organophosphate pesticides are a class of chemicals widely used in agriculture to control pests. Unlike organochlorines, these compounds are generally less persistent in the environment as they undergo faster degradation through hydrolysis and microbial action. Their primary toxicological mechanism involves the inhibition of acetylcholinesterase, an enzyme essential for nerve impulse transmission. This inhibition leads to an accumulation of neurotransmitters, causing overstimulation of the nervous system.

43. (D) X-ray Diffraction (XRD)
X-ray diffraction is the most appropriate analytical technique for determining the internal atomic arrangement and crystal structure of solid materials. When X-rays interact with a crystalline sample, they are scattered in specific patterns that reflect the spacing and orientation of atoms within the lattice. By analyzing these diffraction patterns, scientists can identify different mineral phases and structural defects in inorganic components of soil samples.

44. (B) Gas-to-particle conversion processes.
Inorganic particulate matter in the atmosphere can be formed through gas-to-particle conversion processes. This occurs when gaseous precursors, such as sulfur dioxide or nitrogen oxides, undergo chemical reactions to form low-volatility products like sulfuric acid or ammonium nitrate. These products then nucleate or condense onto existing particles, creating solid or liquid aerosols. This transformation is a major pathway for the production of fine atmospheric particles.

45. (C) 1, 3, and 4 only
Persistent organic pollutants are chemicals that remain in the environment for long periods and accumulate in the food chain. Dichlorodiphenyltrichloroethane, polychlorinated biphenyls, and dioxins are well-known examples of these substances due to their stability and toxicity. In contrast, carbon monoxide and ozone are atmospheric gases with relatively short lifetimes and do not exhibit the same bioaccumulative and persistent characteristics that define persistent pollutants.

46. (D) The mobile phase in GC is a gas, while in HPLC it is a liquid.
The primary distinction between gas chromatography and high-performance liquid chromatography lies in the nature of the mobile phase used to transport the sample. In gas chromatography, an inert gas such as helium or nitrogen serves as the mobile phase to move volatile substances through the column. Conversely, high-performance liquid chromatography utilizes a liquid solvent, often under high pressure, to separate non-volatile organic compounds.

47. (A) Thermal (heat) energy
A thermochemical reaction is a chemical process that is primarily driven by thermal energy. Unlike photochemical reactions, which require the absorption of light, or electrochemical reactions, which involve electricity, thermochemical processes depend on the temperature of the system to overcome the activation energy barrier. These reactions can either release heat into the surroundings, known as exothermic, or absorb heat from them, known as endothermic.

48. (B) Oxidation state and chemical form
The toxicity of arsenic is highly variable and depends strongly on its chemical form and oxidation state. Inorganic forms, particularly trivalent arsenite, are generally much more toxic than pentavalent arsenate or organic arsenic compounds. These different species interact with biological systems in unique ways, affecting their absorption and distribution. Therefore, measuring only the total arsenic concentration is insufficient for accurately assessing potential health risks.

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49. (B) It controls the relative distribution of CO2, HCO3-, and CO3^2-.
The pH level of natural water plays a critical role in determining the relative abundance of different species within the carbonate system. At low pH, dissolved carbon dioxide and carbonic acid are the dominant forms. As the pH increases towards neutrality, the bicarbonate ion becomes most prevalent, providing buffering capacity. In highly alkaline conditions, the carbonate ion eventually becomes the major species. This distribution is essential.

50. (A) Denitrification
Denitrification is a key microbial process in the nitrogen cycle that converts nitrates back into gaseous nitrogen. This transformation typically occurs under anaerobic conditions, where specific bacteria use nitrate as an alternative electron acceptor for respiration instead of oxygen. By releasing nitrogen gas into the atmosphere, denitrification completes the cycle and prevents the excessive accumulation of nitrates in soil and water. It is essential.

51. (C) Thermochemical are driven by heat while photochemical are initiated by light.
Thermochemical and photochemical reactions differ fundamentally in the source of energy that initiates the chemical transformation. Thermochemical reactions are driven by heat, or thermal energy, which increases the kinetic energy of molecules until they can overcome the activation energy barrier. In contrast, photochemical reactions are triggered by the absorption of photons, typically from solar radiation. This input of light energy allows molecules to reach excited states.

52. (A) P-3, Q-4, R-1, S-2
Different analytical techniques are chosen based on the specific information required about a sample. Gas chromatography-mass spectrometry is ideal for identifying and quantifying volatile organic compounds. Inductively coupled plasma-atomic emission spectrometry is used for multi-elemental analysis of trace metals. Fourier-transform infrared spectroscopy identifies functional groups within organic molecules. Scanning electron microscopy is a powerful tool for imaging the surface morphology and topography of particles.

53. (C) Nervous system
Lead is a potent neurotoxin that poses significant health risks, particularly during early childhood development. Exposure to lead can interfere with the normal functioning of the nervous system, leading to cognitive impairments, behavioral problems, and developmental delays. It can cross the blood-brain barrier and mimic essential minerals, disrupting neurotransmission and causing permanent damage to brain structures. Consequently, reducing lead exposure remains a major health priority.

54. (B) Phase transitions driven by thermal changes.
The process of a substance transitioning directly from a solid to a gaseous state and then back to a solid is an application of phase transitions driven by thermal changes. Known as sublimation and deposition, these transitions occur when the temperature and pressure conditions allow a material to bypass the liquid phase. This principle is often used in laboratory settings for the purification of specific compounds.

55. (D) The water molecules bound to the cellulose of the paper.
In paper chromatography, the separation of components is achieved through the interaction between a mobile phase and a stationary phase. While the paper itself provides the physical support, the actual stationary phase is the layer of water molecules that are chemically bound to the cellulose fibers of the paper. As the liquid solvent moves up the paper, the different analytes partition themselves between this stationary layer and the mobile phase.

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56. (A) Condensation of low-volatility organics from VOC oxidation.
The formation of secondary organic aerosols in the atmosphere is primarily driven by the oxidation of volatile organic compounds. When VOCs react with atmospheric oxidants like hydroxyl radicals or ozone, they form products with much lower volatility. These semi-volatile organic compounds then condense onto existing particles or undergo nucleation to create new organic particulate matter. This process significantly contributes to the mass of fine atmospheric particles.

57. (C) Volcanic eruptions

Anthropogenic sources of sulfur to the atmosphere are those resulting from human activities. Major contributors include the burning of high-sulfur coal in power plants, the smelting of sulfide ores to produce metals, and various processes in petroleum refining. These activities release significant amounts of sulfur dioxide. In contrast, volcanic eruptions are natural phenomena that release sulfur but are not considered anthropogenic sources, although they can have large atmospheric impacts.

58. (A) Both A and R are true and R is the correct explanation of A.
The chemical oxygen demand value of a water sample is almost always greater than or equal to its biochemical oxygen demand. This occurs because the chemical test utilizes a strong oxidizing agent, such as potassium dichromate, which can break down nearly all organic matter present. In contrast, the biological test relies on microorganisms that can only decompose the biodegradable portion of the organic load. COD provides comprehensive measures.

59. (D) It is known as the detergent of the troposphere.
The hydroxyl radical is often referred to as the detergent of the troposphere because of its vital role in cleansing the atmosphere. It is a highly reactive species that initiates the oxidation and removal of many trace gases and pollutants. Despite its extremely low concentration and short lifetime, it is the primary oxidizing agent in the lower atmosphere. Its production is driven by sunlight, meaning its concentration peaks during the day.

60. (B) Weighing a pure compound related to the analyte.
Gravimetric analysis is a quantitative analytical method based on the measurement of mass. The process involves converting a dissolved analyte into a solid, pure compound of known chemical composition, typically through precipitation. This solid is then carefully filtered, washed, dried, and weighed. By using the stoichiometric relationship between the final weighed compound and the original analyte, the concentration of the substance in the sample can be calculated precisely.

61. (C) It is a known human carcinogen and highly toxic.
Hexavalent chromium is a significant environmental concern due to its high toxicity and mobility. Unlike the trivalent form, which is an essential nutrient at trace levels, chromium six is a known human carcinogen and can cause severe health issues upon inhalation or ingestion. It is often released into the environment through industrial processes. Due to its solubility, it can easily contaminate groundwater, posing a long-term risk.

62. (D) 1, 3 only, as steps 2 and 4 are not part of nitrification.
Nitrification is a two-step biological process where ammonia is converted into nitrate by specialized aerobic bacteria. The first step involves the oxidation of ammonia to nitrite, primarily performed by bacteria like Nitrosomonas. In the second step, nitrite is further oxidized to nitrate, a process typically carried out by organisms such as Nitrobacter. While mineralization and organic uptake are related to the broader nitrogen cycle, they are not part of nitrification.

63. (A) Electrophoresis
Electrophoresis is an analytical technique used to separate and analyze charged molecules, such as proteins and nucleic acids, based on their migration in an electric field. When a voltage is applied across a buffer solution, the ions move towards the electrode of opposite charge. The speed of this movement depends on the size, shape, and net charge of the molecules. This method is widely used in environmental biology studies.

64. (B) The sum of the exponents in the reaction rate law.
In chemical kinetics, the order of a reaction is a quantitative parameter that describes the relationship between the concentrations of reactants and the rate of the reaction. It is defined as the sum of the exponents to which the reactant concentrations are raised in the experimentally determined rate law. The order provides insight into the reaction mechanism and how sensitive the process is to changes in reactant amounts.

65. (B) 1, 3 and 4 only

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The ozone layer in the stratosphere is essential for life as it absorbs most of the Sun's harmful ultraviolet-B radiation. While the formation and breakdown of ozone are natural processes, the presence of certain chemicals, like chlorine radicals, can accelerate its destruction. Conversely, ground-level or tropospheric ozone is a harmful pollutant and a key component of smog. Understanding these different roles is vital for protecting health and the global environment.

66. (A) It has the general formula CnH2n+2 for non-cyclic alkanes.
Saturated hydrocarbons, also known as alkanes, are organic compounds consisting entirely of single bonds between carbon atoms. For non-cyclic molecules, they follow the general chemical formula of C n H two n plus two. This structure means they contain the maximum possible number of hydrogen atoms. Because they lack double or triple bonds, they are generally less reactive than unsaturated hydrocarbons and do not easily participate in addition reactions.

67. (C) Biomagnification
Biomagnification is the process by which the concentration of certain persistent and lipophilic substances increases at each successive level of a food chain. Unlike bioaccumulation, which occurs within a single organism over time, biomagnification describes the trend across different trophic levels. Toxic substances like mercury and certain pesticides become more concentrated in the tissues of predators as they consume contaminated prey. This phenomenon leads to high toxin levels in predators.

68. (D) Radiofrequency absorption by nuclei in a magnetic field.
Nuclear magnetic resonance spectroscopy is an analytical technique that exploits the magnetic properties of certain atomic nuclei. When placed in a strong external magnetic field, these nuclei align themselves in specific energy states. By applying radiofrequency radiation, the nuclei can be excited between these states, and the resulting absorption is measured. This method provides detailed information about the chemical environment and structure of molecules, making it powerful for identifying compounds.

69. (C) Oxidation of methane (CH4)
While human activities like vehicle emissions are major sources of carbon monoxide, several natural processes also contribute to its presence in the atmosphere. The most significant natural source is the atmospheric oxidation of methane, which is released from various biological and geological sources. Other natural contributors include forest fires and volcanic activity. Understanding these natural pathways is essential for accurately modeling the global carbon monoxide budget and its diverse environmental influences.

70. (B) 2, 3, and 4 only
The formation of photochemical smog requires three main ingredients: nitrogen oxides, volatile organic compounds, and sunlight. These primary pollutants are often emitted from vehicles and industrial processes. When exposed to solar radiation, they undergo complex chemical reactions to produce secondary pollutants like ground-level ozone and peroxyacetyl nitrate. While sulfur dioxide and particulate matter are involved in other types of smog, they are not the defining components of the photochemical variety.

71. (D) Oxidizing conditions
In environmental chemistry, a high positive value for the redox potential indicates an oxidizing environment. This condition suggests that the system has a strong tendency to accept electrons, which is typically found in waters with high concentrations of dissolved oxygen. In such environments, chemical species are likely to exist in their more oxidized states, such as nitrate instead of ammonium. Monitoring redox potential is crucial for understanding the behavior of pollutants.

72. (A) To atomize and excite the atoms of elements in the sample.
In inductively coupled plasma-atomic emission spectrometry, the plasma serves as a high-temperature energy source. Its primary function is to atomize the sample and excite the resulting atoms to higher energy states. As these excited atoms return to their ground state, they emit light at characteristic wavelengths unique to each element. By measuring the intensity of this light, the instrument can precisely identify and quantify the different metallic elements present in samples.

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73. (C) Chemical structure
Pesticides are categorized into several classes, such as organochlorines, organophosphates, and carbamates, based primarily on their chemical structure and functional groups. These groups share similar atomic arrangements and chemical properties, which often determine their environmental behavior and toxicological mechanisms. For example, organophosphates and carbamates both target the nervous system but have different compositions. Classifying pesticides in this way helps scientists and regulators understand their potential ecosystem impacts and persistence.

74. (A) Both Statement I and Statement II are true.
Water treatment utilizes both physical and chemical processes to ensure the removal of various impurities. Filtration is a physical process that uses a porous medium, such as sand or membranes, to mechanically trap and remove suspended solids from water. In contrast, coagulation is a chemical process where specific agents are added to neutralize the electrical charges on colloidal particles. This allows the particles to come together for easier removal in subsequent stages.

75. (D) Absorb and re-emit outgoing infrared radiation.
The greenhouse effect is a natural phenomenon where certain gases in the Earth's atmosphere trap heat. These greenhouse gases, such as carbon dioxide and methane, allow incoming solar radiation to pass through but absorb the outgoing infrared radiation emitted by the Earth's surface. This absorbed energy is then re-emitted in all directions, including back towards the surface, which keeps the planet warmer than it would otherwise be. Human activities increase this effect.

76. (B) Decomposed stable organic matter in the soil.
Humus is the complex, stable organic material that remains in the soil after the extensive decomposition of plant and animal residues by microorganisms. It is a dark, amorphous substance that significantly enhances soil quality by improving its structure, increasing its water-holding capacity, and providing a reservoir of essential nutrients. Unlike the living microbial biomass, humus represents a long-term storage of carbon and is a vital component of healthy terrestrial ecosystems.

77. (C) Surface topography and morphology.
Scanning electron microscopy is a powerful imaging technique used to observe the detailed characteristics of a sample's surface. By scanning the surface with a focused beam of electrons, the instrument generates high-resolution images that reveal the topography and morphology of particles and materials at a microscopic scale. This information is essential for identifying the physical nature of various pollutants and studying structural features of inorganic and organic components in environmental samples.

78. (B) P-3, Q-4, R-2, S-1
Various atmospheric species play unique and vital roles in environmental chemistry. Stratospheric ozone acts as a primary absorber of harmful ultraviolet radiation, while the hydroxyl radical serves as the main oxidizing agent or detergent in the troposphere. Carbon monoxide is a dangerous chemical asphyxiant produced during incomplete combustion. Sulfur dioxide is a significant pollutant that acts as a major precursor to acid rain formation. Understanding these roles is essential for managing quality.

79. (A) The extent to which a sparingly soluble ionic compound dissolves.
The solubility product constant is a thermodynamic value that quantifies the equilibrium between a sparingly soluble ionic compound and its dissolved ions in a saturated solution. It provides a measure of the extent to which the compound can dissolve in water under specific conditions. A lower value indicates that the substance is less soluble. This constant is crucial for predicting whether a precipitate will form when different ionic solutions are mixed.

80. (B) Cancer
A carcinogen is any substance, organism, or agent that is known to promote the development of cancer in living tissues. These substances can act by damaging the DNA of cells directly or by interfering with normal cellular processes, leading to uncontrolled cell growth and tumor formation. Environmental pollutants such as asbestos, certain heavy metals, and various organic chemicals like benzene are recognized

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carcinogens. Assessing exposure to these agents is a fundamental goal.

81. (B) High-temperature oxidation of SO2 to SO3.
The formation of inorganic particulate matter can occur through various chemical pathways in the atmosphere. High-temperature oxidation of sulfur dioxide to sulfur trioxide is a prime example of a thermochemical process, often occurring in industrial combustion stacks. Once formed, sulfur trioxide rapidly reacts with water vapor to create sulfuric acid droplets, which can then react with other gases like ammonia to form solid particles. These processes contribute to fine aerosol production.

82. (A) Transmittance or Absorbance vs. Wavenumber
In Fourier-transform infrared spectroscopy, the resulting data is typically presented as a spectrum that plots either transmittance or absorbance against wavenumber. The wavenumber represents the number of waves per unit length and is proportional to the energy of the infrared radiation. This plot shows characteristic peaks that correspond to the specific vibrational frequencies of chemical bonds within the sample. These patterns allow scientists to identify functional groups and determine molecular structures.

83. (A) Both A and R are true and R is the correct explanation of A.
The biogeochemical cycle of phosphorus is unique because it lacks a significant atmospheric component compared to the nitrogen and carbon cycles. Most phosphorus compounds are non-volatile and exist primarily in solid forms within sedimentary rocks, soil, and aquatic ecosystems. These phosphates move through the environment through processes like geological weathering, plant uptake, and sedimentation rather than gaseous atmospheric transport. Consequently, the atmospheric reservoir is very small, consisting mainly of dust particles.

84. (D) Methylmercury
Minamata disease is a severe neurological condition caused by acute and chronic poisoning from methylmercury. This toxic organic form of mercury was historically released into Minamata Bay by industrial processes, where it then entered the aquatic food chain and biomagnified in fish and shellfish. Humans who consumed large quantities of these contaminated seafood products developed debilitating symptoms, including loss of coordination and cognitive impairment. This disaster underscored the dangers of uncontrolled industrial mercury pollution.

85. (C) To remove heavy particles by gravity.
Sedimentation is a fundamental physical process in water treatment that utilizes the force of gravity to clarify water. During this stage, water is held in large basins where the flow velocity is significantly reduced. This allows suspended particles and flocs, which are denser than water, to settle at the bottom of the tank. By effectively removing these heavy solids, sedimentation reduces the workload for subsequent filtration steps and improves overall water clarity and quality.

86. (B) ICP-AES measures light; ICP-MS measures mass-to-charge.
Both inductively coupled plasma-atomic emission spectrometry and inductively coupled plasma-mass spectrometry use high-temperature plasma to atomize samples. However, they differ in how they detect and measure elements. The emission spectrometry method measures the intensity of light emitted at specific wavelengths by excited atoms. In contrast, the mass spectrometry method separates and detects the ions produced in the plasma based on their specific mass-to-charge ratio. Generally, mass spectrometry offers much greater sensitivity for trace analysis.

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87. (D) Denitrification
The carbon cycle involves various processes that move carbon between the atmosphere, oceans, and living organisms, including photosynthesis, respiration, and the combustion of fossil fuels. These processes involve the exchange of carbon dioxide and other carbon-containing compounds. In contrast, denitrification is a specific biological process that belongs to the nitrogen cycle. It involves the conversion of nitrates into gaseous nitrogen by microorganisms under anaerobic conditions. Therefore, it does not directly participate in carbon movement.

88. (A) Partitioning between an adsorbent plate and a solvent.

Thin-layer chromatography is a widely used analytical technique for separating and identifying chemical components in a mixture. The principle is based on the differential partitioning of substances between a stationary phase, typically an adsorbent material like silica gel on a plate, and a liquid mobile phase. As the solvent moves up the plate by capillary action, different compounds travel at different rates due to their varying affinities for the adsorbent and the solvent front.

89. (C) Average time a molecule remains in the atmosphere.
The term residence time in atmospheric chemistry refers to the average duration that a molecule of a specific chemical species remains in the atmosphere before it is removed by physical or chemical processes. This parameter is crucial for understanding the environmental impact of pollutants. Species with long residence times can accumulate and be transported over great distances, while those with short residence times are removed near their sources. It is calculated from total amount.

90. (C) 1, 3 and 4 only
Volatile organic compounds are organic chemicals characterized by high vapor pressure at room temperature, allowing them to evaporate easily into the atmosphere. They originate from both natural and human activities and serve as critical precursors in the formation of photochemical smog. Methane is often considered separately from other volatile organic compounds because its atmospheric reactivity is significantly lower. Understanding these compounds is essential for managing air quality and protecting health in urban environments.

91. (D) The time required for half of the atoms to undergo decay.
The half-life of a radioisotope is a fundamental physical property defined as the time required for half of the atoms in a given sample to undergo radioactive decay. This rate of decay is constant for each specific isotope and is unaffected by external factors like temperature or pressure. Half-life is a critical parameter for determining the longevity of radioactive pollutants in the environment and for applications such as radiometric dating of diverse archaeological materials.

92. (B) High water temperature and high load of organic waste.
Several environmental factors can lead to dangerously low concentrations of dissolved oxygen in aquatic systems. High water temperatures decrease the solubility of oxygen gas, making less available for aquatic life. Additionally, a high load of organic waste promotes the growth of aerobic bacteria, which consume oxygen rapidly during decomposition. This combination of factors can lead to hypoxic conditions, which are harmful to fish and other organisms. Addressing these pollution sources is vital.

93. (C) Obtain images of the internal structure of a thin specimen.
Transmission electron microscopy is a high-resolution imaging technique used to examine the internal structure of very thin specimens. By passing a beam of electrons through the sample, the instrument creates a detailed image based on the interaction of electrons with the specimen's atoms. This method provides much higher magnification and resolution than optical microscopes, allowing scientists to see individual atomic layers and fine structural features in nanomaterials and biological tissues. It is essential.

94. (D) It is an essential micronutrient at low concentrations but toxic at high concentrations.
The biochemical behavior of selenium is complex because of its dual role in living organisms. At low concentrations, it is an essential micronutrient necessary for the function of certain enzymes and the protection of cells against oxidative damage. However, the range between the required amount and the level at which it becomes toxic is exceptionally narrow. High intake of selenium can lead to severe poisoning in both humans and wildlife. This narrow window exists.

95. (C) 1, 3 and 4 only
Persistent organic pollutants are defined by several key characteristics that make them particularly hazardous to the environment. They are highly resistant to natural degradation processes, allowing them to remain active for many years. Their stability and volatility enable them to undergo long-range atmospheric transport, often reaching polar regions far from

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their origin. Furthermore, these substances are lipophilic and tend to bioaccumulate in fatty tissues, becoming more concentrated as they move up the food chain.

96. (B) It is the step that determines the overall rate.
In a chemical reaction that occurs through multiple elementary steps, the rate-determining step is the one that proceeds most slowly. Because the overall reaction cannot go faster than its slowest component, this specific step dictates the total rate at which products are formed. Identifying the rate-determining step is essential for understanding reaction mechanisms and for designing strategies to accelerate processes in industrial chemistry or to predict the fate of pollutants in systems.

97. (B) The incomplete combustion of organic materials.
Polycyclic aromatic hydrocarbons are a large group of organic compounds produced primarily through the incomplete combustion of organic materials, such as coal, oil, gas, wood, and garbage. They are often found in the air attached to soot particles and are a major component of urban air pollution. Many of these compounds are known carcinogens and pose health risks upon inhalation. Identifying their sources is critical for developing effective air quality management strategies.

98. (A) The concentration and path length of the light.
Beer-Lambert's law is a fundamental principle in spectrophotometry that describes how light is absorbed by a substance in solution. It states that the absorbance is directly proportional to both the concentration of the absorbing species and the distance the light travels through the sample, known as the path length. This linear relationship allows scientists to calculate the exact concentration of an unknown sample by measuring its absorbance and comparing it to known laboratory standards.

99. (C) To regulate climate and redistribute water globally.
The hydrological cycle is a vital Earth system process that ensures the continuous movement and recycling of water across the planet. Its primary function is to regulate the global climate and redistribute water between the oceans, atmosphere, and land. Through processes like evaporation, precipitation, and runoff, the cycle helps to transport heat and nutrients, maintain river flows, and recharge groundwater reservoirs. This continuous circulation is essential for supporting life and shaping the Earth's landscapes.

100. (A) Both Statement I and Statement II are true.
Analytical chemistry utilizes several quantitative methods to determine the concentration of substances in a sample. Titrimetry is a widely used technique where the volume of a standard solution required to react completely with an analyte is measured. Gravimetry is another fundamental quantitative method that involves separating the analyte from the sample as a pure solid precipitate. By measuring the mass of this precipitate, the amount of the original substance can be calculated using stoichiometric relationships.

101. (C) Reversible reactions where the rates of the forward and reverse reactions are equal.
Chemical equilibrium is a dynamic state that occurs in reversible reactions when the rate of the forward reaction equals the rate of the reverse reaction. At this point, the concentrations of reactants and products remain constant over time, although the individual molecules continue to react. This concept is fundamental for predicting the distribution of chemical species in natural systems, such as the atmosphere and oceans, where many processes are balanced between opposing reactions rather than completion.

102. (B) Carbaryl
Carbamate pesticides are a class of organic compounds derived from carbamic acid. They are widely used in agriculture and residential settings to control insects and other pests. Carbaryl is a well-known example of this group, frequently used for its effectiveness and relatively short environmental persistence compared to older organochlorine pesticides. Like organophosphates, carbamates act by inhibiting the enzyme acetylcholinesterase in the nervous system of pests. Understanding pesticide types is essential for managing their health impacts.

103. (A) P-3, Q-2, R-1, S-4

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Each biogeochemical cycle is characterized by its own set of major reservoirs where the element is stored for various lengths of time. For the nitrogen cycle, the atmosphere is the primary reservoir, containing vast amounts of inert nitrogen gas. The phosphorus cycle depends heavily on sedimentary rocks, as it lacks a significant gaseous phase. Carbon moves primarily between the oceans and the atmosphere, while the sulfur cycle involves significant storage within both Earth's rocks and oceans.

104. (A) Excited atomic oxygen (O(1D))
In the upper atmosphere, the absorption of high-energy ultraviolet radiation by ozone molecules leads to a process called photolysis. When ozone is struck by light with wavelengths shorter than three hundred twenty nanometers, it splits into molecular oxygen and a highly reactive, excited-state oxygen atom. This specific radical is essential for atmospheric chemistry because it can react with water vapor to produce hydroxyl radicals, which are the primary oxidizing agents responsible for cleansing the troposphere.

105. (C) It offers high resolution, speed, and sensitivity.
High-performance liquid chromatography offers several significant advantages over traditional column chromatography for environmental analysis. By using fine particles in the stationary phase and pumping the mobile phase at high pressure, the technique provides much greater separation resolution and faster analysis times. Additionally, the use of sensitive detectors allows for the identification and quantification of chemical species at low concentrations. These features make it an essential tool for monitoring complex mixtures of non-volatile pollutants in water.

106. (A) DO levels will decrease.
In aquatic ecosystems, the concentration of dissolved oxygen is balanced by several biological and physical processes. Photosynthesis by plants and algae produces oxygen, while respiration by all living organisms consumes it. If the total rate of respiration in a water body exceeds the rate of oxygen production through photosynthesis, the level of dissolved oxygen will begin to decrease. This situation often occurs in heavily polluted waters or at night when photosynthesis stops, potentially harming aquatic animals.

107. (D) The reaction has stopped completely.
A chemical reaction at equilibrium is characterized by a dynamic state where the concentrations of all reactants and products remain constant over time. This occurs because the rates of the forward and reverse reactions are exactly equal, meaning there is no net change in the system. Thermodynamically, the change in Gibbs free energy for the reaction is zero. However, it is a common misconception that the reaction has stopped; in reality, individual molecular transformations continue in both directions.

108. (A) Both A and R are true and R is the correct explanation of A.
Organochlorine pesticides, such as the well-known compound DDT, are notorious for their ability to undergo biomagnification in the environment. These chemicals are highly lipophilic, meaning they are soluble in fats and oils, and they are also extremely resistant to natural degradation. Because of these properties, they accumulate in the fatty tissues of living organisms and are passed on to predators when they consume their prey. As a result, the concentration of these toxins increases significantly.

109. (C) To vaporize the sample into free ground-state atoms.
In both flame photometry and atomic absorption spectrophotometry, the flame serves a critical role in sample preparation and analysis. Its primary purpose is to provide high-temperature energy necessary to vaporize the liquid sample and break apart chemical compounds into individual ground-state atoms in the gas phase. These free atoms are then capable of either emitting light after being excited or absorbing specific wavelengths of light from an external source. This atomization step is essential for detection.

110. (D) Ultraviolet (UV) and Visible
Photochemical reactions in the troposphere are initiated when atmospheric molecules absorb energy from solar radiation. The specific parts of the electromagnetic spectrum responsible for these transformations are the ultraviolet and visible regions. While high-energy UV-C radiation is mostly absorbed by the stratosphere, enough UV-B and UV-A light, along with visible

NODIA

light, reaches the lower atmosphere to drive critical processes. These include the photolysis of nitrogen dioxide and the formation of ground-level ozone in urban areas.

111. (A) Bind hemoglobin, reducing oxygen-carrying capacity.
The toxicity of carbon monoxide to humans and other animals is primarily due to its high affinity for hemoglobin in the blood. When inhaled, carbon monoxide molecules bind to the iron atoms in hemoglobin much more strongly than oxygen does, forming a stable complex called carboxyhemoglobin. This prevents the hemoglobin from carrying sufficient oxygen to the body's tissues and organs. Even at relatively low concentrations, this reduction in oxygen transport can lead to serious health problems.

112. (B) 2, 4, 3, 1
The development of chromatographic techniques has progressed significantly over time, starting with simpler methods and moving toward more advanced and automated systems. Paper chromatography was one of the earliest forms developed for separating chemical mixtures. This was followed by thin-layer chromatography, which offered better resolution on solid plates. Gas chromatography was subsequently introduced for analyzing volatile substances, and finally, high-performance liquid chromatography was developed to provide high-speed and high-resolution separation of non-volatile and complex samples.

113. (B) A negative Eh and presence of CH4, H2S, and Fe^2+.
A reducing environment in soil or aquatic sediments is characterized by the absence of oxygen and other strong oxidizing agents. Such conditions are indicated by a negative redox potential. In these environments, chemical species exist in their more reduced forms, such as methane, hydrogen sulfide, and divalent iron. These conditions are typically found in waterlogged soils or deep lake sediments where microbial decomposition of organic matter has depleted the available oxygen, shifting the chemical balance.

114. (A) GC separates compounds and MS provides identification.
The coupling of gas chromatography with mass spectrometry creates a powerful analytical tool widely used in environmental forensic and monitoring studies. Gas chromatography provides the ability to separate the individual components of a complex mixture based on their volatility and interaction with the stationary phase. Once separated, each component enters the mass spectrometer, which generates a unique mass spectrum for identification and quantification. This combination allows for highly sensitive and definitive analysis of volatile organic pollutants.

115. (A) 1, 2 and 3 only
The carbonate system is a fundamental component of natural water chemistry, playing a major role as a pH buffer. It involves a complex equilibrium between dissolved carbon dioxide, carbonic acid, bicarbonate ions, and carbonate ions. At a neutral pH of approximately seven, the bicarbonate ion is typically the dominant species. Total alkalinity in most natural waters is primarily contributed by the components of this system. Understanding these interactions is essential for studying chemical stability.

116. (D) Carbon monoxide (CO) from car exhaust
Air pollutants are classified as either primary or secondary based on how they enter the atmosphere. Primary pollutants are those emitted directly from a source into the air. Carbon monoxide released from vehicle exhaust is a classic example of a primary pollutant produced by the incomplete combustion of fuels. In contrast, secondary pollutants like ozone, sulfuric acid, and peroxyacetyl nitrate are formed through chemical reactions between other substances already present in the atmosphere, driven by solar radiation.

117. (C) Volume of a standard solution required to react completely with the analyte.
In titrimetry, the concentration of an unknown analyte is determined by measuring a specific physical property during a chemical reaction. The primary measurement is the volume of a standard solution, called the titrant, which has a precisely known concentration. This titrant is added gradually until the reaction with the analyte is complete, a point known as the equivalence point. By knowing the volume used

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and the stoichiometry, scientists calculate the exact concentration of the substance.

118. (B) The dose lethal to 50% of a test population.
In toxicology, the term LD fifty stands for lethal dose fifty percent and is used as a standard measure of acute toxicity for a specific substance. It represents the calculated dose required to kill exactly half of a tested population, such as lab rats or fish, under controlled laboratory conditions. This value allows researchers and regulators to compare the relative toxicities of different chemicals and to establish safety guidelines and exposure limits for humans and ecosystems.

119. (D) Atmospheric nitrogen to nitrogenous compounds.
Nitrogen fixation is a critical biological and chemical process that converts relatively inert atmospheric nitrogen gas into reactive nitrogenous compounds like ammonia. This transformation is essential because most living organisms cannot use nitrogen directly from the air. The process is primarily carried out by specialized microorganisms, such as certain bacteria and archaea, and can also occur through abiotic pathways like lightning or industrial processes. Once fixed, nitrogen becomes available for uptake by plants, supporting life.

120. (A) 1, 2, 4, and 5 only
The chemistry of oxygen and ozone in the atmosphere involves several fundamental processes. The Chapman cycle describes the natural formation and destruction of ozone in the stratosphere, initiated by the photolysis of molecular oxygen by ultraviolet radiation. This reaction produces individual oxygen atoms that combine with oxygen molecules to form ozone. While stratospheric ozone is protective, tropospheric ozone is a pollutant formed through different mechanisms. Ozone is also recognized as a powerful oxidizing agent.

121. (C) The underlying geological material from which the soil is formed.
In soil science, the term parent material refers to the underlying geological substance from which a particular soil has developed over time. This material can consist of solid bedrock or loose sediments deposited by wind, water, or ice. The chemical and physical properties of the parent material significantly influence the initial characteristics of the resulting soil, including its mineral composition and texture. Over thousands of years, weathering and biological activity transform this foundation into soil.

122. (A) X-ray Fluorescence (XRF)
X-ray fluorescence is an analytical technique based on the interaction between high-energy radiation and the internal electrons of an atom. When a sample is bombarded with X-rays, an electron can be ejected from one of the inner atomic shells. As an electron from an outer shell falls into the vacancy, it releases energy in the form of characteristic X-rays. By measuring these specific energy emissions, scientists can identify and quantify the different elements in a sample.

123. (D) Pressed wood products and furniture.
Indoor air quality can be significantly affected by various sources of pollution found within buildings. Pressed wood products, such as particleboard and plywood, along with certain types of furniture and building materials, are major contributors to indoor levels of volatile organic compounds like formaldehyde. These chemicals are often released from the adhesives and resins used in manufacturing through off-gassing. Other indoor pollutants include radon gas and combustion products, but furniture remains a primary organic source.

124. (B) The concentration raised to the power of one.
In chemical kinetics, the rate of a first-order reaction is defined by its dependence on the concentration of a single reactant. Specifically, the reaction rate is directly proportional to the concentration of that reactant raised to the power of one. This means that if the concentration is doubled, the rate of the reaction will also double. Understanding reaction orders is essential for predicting how the speed of chemical processes will change and for modeling the environmental persistence.

125. (C) The Oxygen Cycle
Biogeochemical cycles describe the movement of essential elements through the Earth's systems. The nitrogen, phosphorus, and sulfur cycles are typically classified as major nutrient cycles because these elements are fundamental components of biological molecules like proteins

NODIA

and DNA. While oxygen is vital for life and moves through various reservoirs, its circulation is usually discussed in the context of water and carbon cycles rather than as a separate nutrient cycle. It is less commonly listed alone.

126. (A) Both Statement I and Statement II are true.
The redox potential of water is a fundamental parameter that indicates its capacity to accept or donate electrons during chemical reactions. It provides essential information about the chemical environment of an aquatic system. A positive value for the redox potential signifies an oxidizing environment where species like oxygen are prevalent. Conversely, a negative value indicates a reducing environment typical of anaerobic conditions. Understanding these relationships is vital for predicting the stability, mobility, and toxicity of various pollutants.

127. (A) Gas Chromatography (GC)
Gas chromatography is the most suitable analytical technique for separating and analyzing complex mixtures of volatile compounds, such as the various hydrocarbons found in gasoline. The process involves vaporizing the sample and using an inert gas to carry the gaseous components through a column containing a stationary phase. Because different molecules have different boiling points and affinities for the stationary phase, they travel at different rates. This allows for the precise identification and quantification of each substance.

128. (A) P-3, Q-4, R-1, S-2
Different environmental pollutants are associated with specific and serious health effects on the human body. Lead is a well-known neurotoxin that can cause permanent damage to the nervous system, while exposure to asbestos fibers is a major cause of lung cancer and mesothelioma. Carbon monoxide acts as a chemical asphyxiant by interfering with oxygen transport in the blood. Ground-level ozone is a powerful respiratory irritant that can exacerbate asthma and other lung conditions.

129. (B) Ozone (O3)
Photochemical smog is a mixture of primary and secondary pollutants formed in the atmosphere under the influence of sunlight. Primary pollutants like nitrogen monoxide and various hydrocarbons are emitted directly from sources like cars. Once in the air, these substances undergo complex chemical reactions to form secondary pollutants. Ozone is one of the most significant secondary pollutants produced during this process. Unlike protective stratospheric ozone, ground-level ozone is a harmful oxidant that causes serious respiratory issues.

130. (A) AAS measures absorbed light, while Flame Photometry measures emitted light.
While both atomic absorption spectrophotometry and flame photometry utilize a flame to atomize samples, they differ fundamentally in the optical principle used for measurement. Flame photometry measures the intensity of light emitted by atoms after they have been excited to higher energy states by the heat of the flame. In contrast, atomic absorption spectrophotometry measures the amount of light absorbed from an external source by ground-state atoms in the vapor phase. Atomic absorption offers greater analytical sensitivity.

131. (C) Hold and exchange positively charged ions (cations).
Cation exchange capacity is a vital chemical property of soil that measures its ability to hold and exchange positively charged ions. This capacity is primarily provided by the negative charges found on the surfaces of clay minerals and organic matter. Essential plant nutrients such as calcium, magnesium, and potassium are held in the soil through these interactions, preventing them from being leached away by water. Understanding a soil's cation exchange capacity is essential for managing overall soil fertility.

132. (D) Equilibrium partitioning between phases.
Henry's Law is a fundamental principle in environmental chemistry that describes the equilibrium partitioning of a gas between the atmosphere and a liquid phase, such as water. It states that at a constant temperature, the amount of a specific gas dissolved in a liquid is directly proportional to its partial pressure in the air above that liquid. This relationship is essential for understanding the exchange of carbon dioxide, oxygen, and various volatile pollutants between water and atmosphere.

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133. (A) Both A and R are true and R is the correct explanation of A.
The hardness of water is a common quality issue primarily caused by the presence of dissolved multivalent cations, most notably calcium and magnesium. These ions enter water sources as they dissolve from rocks and minerals like limestone. The presence of these cations interferes with the action of soap by reacting with it to form an insoluble precipitate, often referred to as soap scum. This process significantly reduces the soap's ability to produce lather and effectively clean.

134. (B) Transmission Electron Microscopy (TEM)
Transmission electron microscopy is the most powerful technique for obtaining high-magnification images of the internal structure of materials at the nanoscale. Unlike scanning electron microscopy, which focuses on surface features, this method passes a beam of electrons through a very thin sample. This allows for the observation of internal atomic arrangements, crystal lattices, and structural defects. It is an indispensable tool in nanotechnology and material science for characterizing the fine details of diverse catalysts and complex inorganic structures.

135. (D) Depleting the stratospheric ozone layer.
The primary environmental concern associated with chlorofluorocarbons is their destructive role in the stratospheric ozone layer. These stable, man-made compounds eventually reach the upper atmosphere, where they are broken down by intense ultraviolet radiation. This process releases chlorine radicals that act as catalysts, repeatedly destroying ozone molecules without being consumed themselves. This depletion allows more harmful UV radiation to reach the Earth's surface, increasing the risk of skin cancer and causing significant damage to various agricultural ecosystems.

136. (A) Zinc and Calcium
Cadmium is a highly toxic heavy metal whose health risks are largely linked to its ability to interfere with the metabolism of essential elements. Because of its chemical similarity to zinc and calcium, cadmium can displace these necessary minerals from their roles in enzymes and cellular structures. This disruption can lead to a wide range of problems, including severe kidney damage and the painful softening of bones, as seen in Itai-itai disease. Understanding these biochemical interactions is vital.

137. (C) It measures light absorption by a solution.
UV-Visible spectrophotometry is a fundamental analytical technique based on the principle that many chemical substances absorb light in the ultraviolet and visible regions of the electromagnetic spectrum. When light of a specific wavelength passes through a solution, the amount of light absorbed is directly proportional to the concentration of the absorbing substance and the length of the path the light travels. By measuring this absorption, scientists can precisely identify and quantify various organic and inorganic compounds.

NODIA

138. (A) The oceans
In the global carbon cycle, carbon is stored in several major reservoirs, including the atmosphere, terrestrial biosphere, fossil fuel deposits, and the oceans. While the atmosphere is the most visible reservoir, the oceans actually hold the largest amount of actively cycling carbon. This carbon exists primarily as dissolved inorganic forms like bicarbonate and carbonate ions. The vast capacity of the oceans to absorb carbon dioxide from the atmosphere plays a critical role in regulating the Earth's climate.

139. (D) (distance by spot) / (distance by solvent)
In planar chromatographic techniques like paper chromatography and thin-layer chromatography, the retention factor, or Rf value, is used to identify substances. It is a dimensionless ratio calculated by dividing the distance traveled by the specific chemical spot by the total distance traveled by the solvent front. Each substance has a characteristic Rf value under specific conditions, which depends on its affinity for the phases. This parameter allows for the easy qualitative identification of various components.

140. (C) 1, 2 and 4 only
Radicals are highly reactive chemical species characterized by the presence of one or more unpaired electrons. In the atmosphere, they play a crucial role in driving chemical transformations and removing pollutants. The hydroxyl radical is the most important oxidant in the troposphere,

initiating the breakdown of many trace gases. These reactive species are typically short-lived and are often formed through photolysis, where sunlight provides the energy needed to break chemical bonds. Radical chemistry is essential.

141. (C) Weathering of limestone and water hardness.
The chemical reaction between calcium carbonate and carbonic acid is a fundamental process in environmental geology and water chemistry. It represents the weathering of limestone and other carbonate rocks by slightly acidic rainwater. This reaction leads to the dissolution of the solid mineral into soluble calcium bicarbonate, which is the primary cause of temporary hardness in natural waters. This process shapes geological features like caves and significantly influences the chemical composition and buffering capacity of aquatic environments.

142. (D) Natural geological mobilization in soil.
While human activities like mining and pesticide use can contribute to arsenic levels, the most widespread source of serious groundwater contamination is natural geological mobilization. In many parts of the world, arsenic is naturally present in certain types of underground rocks and sediments. Under specific chemical conditions, such as changes in redox potential or pH, this arsenic can be released into the surrounding groundwater. This has led to major public health crises where people rely on untreated well water.

143. (A) Inductively Coupled Plasma - Mass Spectrometry (ICP-MS)
Chromatography refers to a group of techniques used to separate the components of a mixture based on their distribution between a stationary and a mobile phase. Common examples include gas chromatography, high-performance liquid chromatography, and thin-layer chromatography. In contrast, inductively coupled plasma-mass spectrometry is a spectroscopic technique used for elemental analysis. It uses a high-temperature plasma to ionize samples and a mass spectrometer to detect the ions. It is an analytical tool, but not a separation method.

144. (B) Minimum energy for reactant transformation.
In chemical kinetics, activation energy is the minimum amount of energy that must be provided to a chemical system to initiate a reaction. It represents the energy barrier that reactants must overcome to transform into products. At a molecular level, this energy is required to break existing chemical bonds and allow the formation of new ones. Substances with high activation energies react slowly, while catalysts can lower this barrier, significantly increasing the reaction rate without being consumed.

145. (B) 1, 2, and 5 only
Primary air pollutants are those that are emitted directly into the atmosphere from identifiable sources. Common examples include carbon monoxide from vehicles, sulfur dioxide from industrial processes, and nitrogen dioxide released from combustion engines. These substances can cause direct harm to health and the environment. In contrast, pollutants like ozone and peroxyacetyl nitrate are considered secondary because they are formed in the air through chemical reactions between other pollutants. Distinguishing between them is essential for management.

146. (A) Mineralization or decomposition
In the biogeochemical sulfur cycle, the process of mineralization or decomposition involves the conversion of organic sulfur compounds back into inorganic forms. During the breakdown of dead plants and animals by microorganisms, sulfur found in proteins and other molecules is released, often in the form of hydrogen sulfide gas under anaerobic conditions. This step is essential for recycling sulfur through the environment and making it available again for further chemical and biological processes in sediments and wetlands.

147. (C) Statement I is false, but Statement II is true.
Water treatment involves a combination of processes designed to remove different types of impurities. Coagulation and flocculation are chemical and physical steps specifically targeted at destabilizing and aggregating fine colloidal particles and suspended solids so they can be easily removed. They are not primarily designed to remove dissolved ions. Filtration is a mechanical process that effectively removes these larger aggregated particles by passing water through a porous medium. However, filtration is generally not effective for removing dissolved substances.

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148. (D) Mercury (Hg)
Mercury is a unique heavy metal that remains in a liquid state at room temperature. It is highly toxic and poses environmental risks because it can be converted by certain microorganisms into methylmercury, a potent organic form. This biomethylation process typically occurs in aquatic sediments under anaerobic conditions. Methylmercury is much more easily absorbed by living organisms and tends to biomagnify up the food chain, reaching dangerous concentrations in predatory fish and humans. Emission management is essential.

149. (C) Molar Gibbs energy
The chemical potential is a thermodynamic property used to describe the stability and reactivity of a substance within a system. For a pure substance, the chemical potential is identical to its molar Gibbs free energy. This value represents the amount of energy associated with one mole of the substance that is available to perform work or drive chemical processes like phase transitions and reactions. In a mixture, the chemical potential depends on the concentration, temperature, and pressure.

150. (B) Is characterized by high concentrations of sulfur dioxide and particulate matter.
London-type smog, often called industrial smog, is fundamentally different from the photochemical smog found in many modern cities. It typically occurs in cold, damp climates and is characterized by high concentrations of sulfur dioxide and particulate matter, primarily from the burning of coal for heating and industry. This mixture of soot and sulfurous gases can form a thick, toxic fog that causes severe respiratory issues. Photochemical smog is driven by sunlight and involves reactions with organic compounds.

151. (D) Uptake of phosphate from soil and water by plants.
The phosphorus cycle involves the movement of phosphorus through various Earth systems, primarily in the form of phosphate ions. A key biological step in this cycle is the uptake of dissolved phosphate from the soil or water by plants and algae. Phosphorus is an essential nutrient used to build critical biological molecules like DNA and ATP. Once absorbed by producers, phosphorus enters the food chain as it is consumed by animals. This uptake is essential.

152. (B) P-3, Q-1, R-2, S-4
Analytical chemistry relies on diverse physical principles to identify and quantify chemical species. X-ray diffraction uses patterns created by X-rays scattered by a crystal lattice to determine structural arrangements. Nuclear magnetic resonance spectroscopy measures absorption of radio waves by nuclei in a magnetic field to identify molecular structures. X-ray fluorescence identifies elements based on characteristic X-rays they emit when excited. Fourier-transform infrared spectroscopy identifies functional groups by measuring the specific vibrational frequencies of chemical bonds in molecules.

153. (C) Carries a net positive or negative electrical charge.
In the context of atmospheric chemistry and physics, a chemical species is classified as an ion if it possesses a net positive or negative electrical charge. These ions are formed when neutral atoms or molecules gain or lose electrons, often due to high-energy radiation from space or electrical discharges like lightning. Although they are present in relatively low concentrations, atmospheric ions play a critical role in processes like cloud formation, electrical conductivity, and diverse chemical transformations.

154. (A) It carries components through the stationary phase.
In any chromatographic technique, the mobile phase plays a vital role by acting as a carrier for the sample mixture. It can be a liquid or a gas that moves continuously through the stationary phase. As the mobile phase travels, it transports the individual components of the mixture at different speeds. The rate of migration for each substance depends on its unique degree of interaction with both the mobile and stationary phases, ultimately allowing for effective separation.

155. (D) Cyclohexane
Saturated hydrocarbons, or alkanes, are organic compounds where all carbon atoms are connected by single covalent bonds. This structure means they contain the maximum possible number of hydrogen atoms and are generally less reactive than unsaturated compounds. Cyclohexane is a

NODIA

prime example of a saturated hydrocarbon where the carbon atoms are arranged in a ring structure. Unlike benzene, which is aromatic, or ethene and acetylene, which contain double and triple bonds, cyclohexane only possesses single bonds.

156. (B) Chemical forms have vastly different toxicities.
Understanding chemical speciation is essential for assessing the environmental and health risks of metals like chromium and arsenic. The total concentration of a metal does not provide enough information because different chemical forms, or species, can exhibit vastly different levels of toxicity and mobility. For example, hexavalent chromium is much more hazardous and soluble than its trivalent counterpart. By identifying the specific oxidation states and molecular forms present, scientists can more accurately predict how pollutants behave.

157. (C) The natural ozone layer in the stratosphere.
The Chapman reactions are a series of fundamental photochemical processes that describe the natural cycle of ozone formation and destruction in the Earth's stratosphere. These reactions are driven by high-energy solar ultraviolet radiation. They explain how molecular oxygen is split into atoms that then combine with other oxygen molecules to create ozone. The cycle also includes the natural breakdown of ozone back into oxygen. Together, these reactions maintain a steady state of protective atmospheric ozone.

158. (A) Both A and R are true and R is the correct explanation of A.
In chemical kinetics, increasing the concentration of reactants is a common way to accelerate the rate of a reaction. This phenomenon is explained by collision theory, which states that for a reaction to occur, the reacting particles must collide with sufficient energy and the correct orientation. A higher concentration means there are more particles in a given volume, leading to a much greater frequency of collisions between them. This increased likelihood of interaction directly results in faster rates.

159. (A) Organophosphates
Organophosphate pesticides are widely used in modern agriculture but are known for their high acute toxicity to humans and other mammals. Their primary mechanism of action involves the inhibition of the enzyme acetylcholinesterase, which is essential for the proper termination of nerve impulses. By blocking this enzyme, organophosphates cause an accumulation of neurotransmitters, leading to continuous nerve overstimulation and potential respiratory failure. While they degrade quickly in the environment, their potent effect makes them particularly hazardous.

160. (B) DO is oxygen present; BOD is oxygen required.
Dissolved oxygen and biochemical oxygen demand are two distinct but related water quality parameters. Dissolved oxygen represents the actual concentration of oxygen gas currently available in a water body to support aquatic life. In contrast, biochemical oxygen demand measures the amount of oxygen that would be required by microorganisms to decompose all the biodegradable organic matter present in a sample. Generally, a high biochemical oxygen demand indicates high levels of organic pollution and potentially low oxygen.

161. (B) A precisely measured volume of a solution.
In analytical chemistry, particularly in titrimetry, an aliquot refers to a precisely measured and representative portion of a larger sample or solution. It is typically withdrawn using a calibrated pipette to ensure high accuracy. By performing an analysis on an aliquot rather than the entire sample, scientists can conduct multiple trials or use different methods on the same material. This approach is essential for obtaining reliable and reproducible results when determining the composition of diverse environmental samples.

162. (C) 4, 2, 1, 3
The Earth's atmosphere is a mixture of various gases with widely different concentrations. Nitrogen is by far the most abundant, making up about seventy-eight percent of dry air. Oxygen is the second most common, accounting for approximately twenty-one percent. Argon is the third most abundant at nearly one percent, followed by carbon dioxide, which is present in trace amounts but is critically important for the climate. Understanding this order of abundance is fundamental for atmospheric chemistry.

NODIA

163. (C) Disrupting enzyme function by binding to sites.
The toxic effects of many heavy metals, such as lead and mercury, stem from their ability to interfere with critical biological processes at the molecular level. A primary mechanism involves these metals binding to specific active sites on enzymes, particularly those containing sulfur or nitrogen. This binding can change the shape of the enzyme or block its activity entirely, disrupting essential metabolic pathways and cellular functions. These interactions can lead to severe neurological damage and organ failure.

164. (D) The substance is lipophilic and bioaccumulates.
The octanol-water partition coefficient is a fundamental parameter used to predict the environmental behavior of organic pollutants. A high value for this coefficient indicates that a substance is more soluble in organic solvents, such as fats and oils, than in water. Such compounds are described as lipophilic. In the environment, these substances are highly likely to bioaccumulate in the fatty tissues of living organisms and biomagnify up the food chain. Understanding this property is essential.

165. (A) 1 and 3 only
Analytical chemistry utilizes various techniques to characterize materials and chemical species. X-ray fluorescence is a well-known non-destructive method for determining the elemental composition of many different samples. Fourier-transform infrared spectroscopy is an essential tool for identifying functional groups present in organic molecules by measuring their unique bond vibrations. In contrast, gas chromatography is typically limited to volatile substances, and scanning electron microscopy primarily provides detailed images of a sample's surface topography rather than its chemical composition.

166. (B) The change in Gibbs' energy (ΔG) is zero.
A chemical reaction is said to be at equilibrium when there is no longer a net change in the concentrations of reactants and products over time. Thermodynamically, this state is defined by the point where the change in Gibbs free energy for the reaction is exactly zero. At this point, the system is at its most stable state under the given conditions, and the rates of the forward and reverse reactions are equal. This concept is fundamental.

167. (D) Nitrogen fixation
The hydrological cycle consists of several major processes that continuously move water between the Earth's surface and the atmosphere. Evaporation from oceans and lakes, transpiration from plants, and condensation into clouds are all critical components of this global circulation. In contrast, nitrogen fixation is a biological and chemical process that belongs to the nitrogen cycle. It involves the conversion of atmospheric nitrogen gas into reactive forms like ammonia and is not part of water movement.

168. (A) Encourage particles to collide and form flocs.
Flocculation is a critical physical stage in water treatment that follows the chemical process of coagulation. Its primary purpose is to provide gentle and slow mixing, which encourages the small, destabilized particles to collide and stick together. This process leads to the formation of larger and heavier aggregates known as flocs. These flocs are then much easier to remove in subsequent treatment steps, such as sedimentation and filtration, effectively clarifying the water and removing suspended impurities.

169. (C) Combustion of organic material with chlorine.
Dioxins and furans are highly toxic and persistent organic pollutants that are rarely produced intentionally. Instead, they are often formed as unintentional byproducts during various industrial and combustion processes. A major source of these chemicals is the burning of organic materials in the presence of chlorine, such as in municipal waste incinerators or during the bleaching of wood pulp in paper mills. Because they are extremely stable and can bioaccumulate, these substances pose significant long-term health risks.

170. (A) 1, 2, and 4 only
The catalytic destruction of stratospheric ozone by chlorine involves a series of complex reactions. The process begins with the presence of chlorine atoms, which are often released from human-made compounds. These reactive atoms attack ozone molecules, forming chlorine monoxide radicals as intermediates. This step

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effectively destroys the ozone while regenerating the chlorine atom, allowing it to repeat the cycle thousands of times. Understanding these reactions is vital for protecting the ozone layer, as they explain environmental damage.

171. (D) Increase water-holding capacity and nutrients.
Humus is the stable, decomposed organic component of soil and plays several vital roles in maintaining terrestrial ecosystem health. One of its primary functions is to significantly increase the soil's water-holding capacity, helping to prevent moisture loss during dry periods. Additionally, humus acts as a reservoir for essential nutrients, slowly releasing them to be used by plants. By improving soil structure and providing a habitat for beneficial microorganisms, humus enhances soil fertility and productivity in ecosystems.

172. (B) The molar ratio of consumption and formation.
In a balanced chemical equation, the stoichiometric coefficient is the number placed in front of a chemical formula to represent the molar proportions of reactants and products involved in the reaction. These coefficients indicate the relative amounts of each substance consumed or formed during the process, ensuring that the law of conservation of mass is satisfied. By using these ratios, scientists can calculate precise quantities of materials needed and predict the expected yield of chemical products.

173. (C) ICP-AES uses plasma emission, AAS uses absorption.
While both inductively coupled plasma-atomic emission spectrometry and atomic absorption spectrophotometry are powerful tools for elemental analysis, they rely on different physical principles. The ICP-AES method utilizes a high-temperature plasma to excite atoms, which then emit light at characteristic wavelengths that are measured by the instrument. In contrast, AAS measures the amount of light absorbed from an external source by ground-state atoms in a vapor phase. Generally, the plasma-based method allows for simultaneous multi-elemental analytical quantification.

174. (C) To remove heavy particles by gravity.
Sedimentation is a fundamental physical process in water treatment that utilizes the force of gravity to clarify water. During this stage, water is held in large basins where the flow velocity is significantly reduced. This allows suspended particles and flocs, which are denser than water, to settle at the bottom of the tank. By effectively removing these heavy solids, sedimentation reduces the workload for subsequent filtration steps and significantly improves overall clarity and quality of treated water.

175. (C) Statement I is true, but Statement II is false.
Radioisotopes are a specific type of atom characterized by an unstable nucleus that spontaneously emits radiation as it decays toward a more stable state. This process of radioactive decay is a fundamental physical phenomenon used in many fields, including medical imaging and environmental tracing. However, it is a common misconception that all isotopes are radioactive. In reality, many elements have stable isotopes that do not undergo decay and remain unchanged indefinitely. Understanding the difference is essential.

176. (B) They are initiated by the absorption of photons.
A key feature of photochemical reactions in the atmosphere is that they are initiated by the absorption of photons, typically from solar radiation. This input of light energy allows molecules to reach excited states and undergo chemical transformations that would not be possible through thermal energy alone. These reactions often involve the formation of highly reactive intermediates like free radicals and ions, which drive many atmospheric processes. Consequently, these reactions are active during daylight hours.

177. (B) Arsenite (As(III))
Arsenic exists in several different chemical forms and oxidation states in natural waters, and its toxicity is highly dependent on these specific speciation characteristics. Among the common forms, trivalent arsenite is generally considered the most toxic to humans and other biological systems. It is more mobile and more easily absorbed by cells compared to its pentavalent counterpart, arsenate. Understanding the distribution of these arsenic species is essential

NODIA

for accurately assessing the health risks from water.

178. (A) P-4, Q-3, R-1, S-2
Various water quality parameters provide essential information about the health and pollution levels of aquatic systems. Dissolved oxygen measures the concentration of oxygen gas available for aquatic life, while biochemical oxygen demand indicates the oxygen used by microorganisms during the decomposition of organic matter. Chemical oxygen demand provides a measure of the total oxygen required for the chemical oxidation of all organic substances. The pH level quantifies the concentration of hydrogen ions, indicating the acidity.

179. (C) Correct for solvent and cuvette absorbance.
In spectrophotometry, a blank sample is an essential part of the analytical process used to ensure the accuracy of the measurements. Its primary purpose is to correct for any light absorption caused by the solvent, the cuvette, or other reagents present in the sample other than the analyte itself. By measuring the blank first and setting it as the zero point, scientists ensure that the final absorbance reading represents only the light absorbed by the analyte.

180. (D) Precursor to acid rain
Sulfur dioxide is a major air pollutant primarily produced by the burning of fossil fuels and the smelting of mineral ores. Its most significant environmental impact is its role as a key precursor to the formation of acid rain. In the atmosphere, sulfur dioxide undergoes oxidation to form sulfur trioxide, which then reacts with water vapor to create sulfuric acid. This acid then falls to the ground in precipitation, causing damage to forests and diverse aquatic ecosystems.

181. (C) Fine porous silica or polymer packed in columns.
In high-performance liquid chromatography, the stationary phase is a critical component that facilitates the separation of chemical species. It typically consists of very fine, porous particles of silica or specialized polymers that are tightly packed into a metal column. The small size and large surface area of these particles allow for high-resolution separation as the mobile phase carries the sample through the column under high pressure. Specific chemical properties of the stationary phase determine component interactions.

182. (B) Non-spontaneous in the forward direction.
The change in Gibbs free energy is a fundamental thermodynamic parameter used to predict the direction of chemical and physical processes. When a reaction has a large positive change in Gibbs free energy, it indicates that the process is highly non-spontaneous in the forward direction. This means the reaction will not occur without a significant and continuous input of external energy. Such processes are thermodynamically unfavorable, and at equilibrium, concentrations of reactants remain much higher than products.

183. (A) Both A and R are true and R is the correct explanation of A.
Photochemical smog is often referred to as an oxidizing smog because it is rich in powerful chemical oxidizing agents. The formation of this type of smog is driven by sunlight and involves complex reactions between nitrogen oxides and various organic compounds. These reactions produce high concentrations of secondary pollutants, most notably ground-level ozone and peroxyacetyl nitrate. Both of these substances are strong oxidants that can irritate respiratory systems and cause significant damage to sensitive plants.

184. (A) Isomorphic substitution of cations in the lattice.
In soil science, the surfaces of clay minerals often possess a significant negative electrical charge, which is essential for their ability to hold and exchange nutrients. The primary source of this charge is a process called isomorphic substitution, where one cation in the mineral's crystal lattice is replaced by another of similar size but lower positive charge. For example, aluminum may replace silicon in the structure. This replacement creates a net negative charge balanced by adsorbed cations.

185. (C) XRD
X-ray diffraction is a specialized analytical technique used to determine the atomic and molecular structure of crystalline materials. The method relies on the fact that when X-rays strike a crystal, they are scattered by the regularly

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spaced atoms in a way that creates a characteristic diffraction pattern. By analyzing the angles and intensities of these scattered rays, scientists can identify specific minerals and phases present in a sample. This technique is important for studying solid inorganic soil components.

186. (A) Low surface tension
Water's reputation as a universal solvent is due to several of its unique physical and chemical properties. Its polar nature, high dielectric constant, and ability to form extensive hydrogen bonds allow it to effectively dissolve a wide range of ionic and polar substances. These characteristics make it a vital medium for biological and environmental processes. In contrast, while water has a relatively high surface tension compared to many other liquids, this property is not directly related to solubility.

187. (D) Radiocarbon dating of organic materials.
Carbon-fourteen is a radioactive isotope of carbon with a well-known half-life of approximately five thousand seven hundred thirty years. This property makes it an invaluable tool for radiocarbon dating, a method used to determine the age of organic materials like wood, bone, and charcoal. Because living organisms continuously exchange carbon with the atmosphere, they maintain a consistent ratio of carbon-fourteen. Once an organism dies, this exchange stops, and the isotope decays at a predictable rate.

188. (B) Low temperature and high pressure
The solubility of gases in water is significantly influenced by both temperature and pressure. According to Henry's Law, increasing the pressure of a gas above a liquid increases its concentration within the liquid. Conversely, decreasing the temperature also promotes gas solubility, as lower temperatures reduce the kinetic energy of the molecules, making them less likely to escape into the gas phase. Therefore, cold water under high pressure can hold the largest amount of dissolved oxygen and other gases.

189. (C) The type of mobile phase used for separation.
Both gas chromatography-mass spectrometry and liquid chromatography-mass spectrometry are powerful analytical systems that combine a separation technique with a detection method. The primary difference between these two systems lies in the nature of the mobile phase used during the initial chromatography step. GC-MS utilizes an inert gas to move volatile samples through the column, making it ideal for gaseous compounds. LC-MS, on the other hand, uses a liquid solvent, better suited for non-volatile or large molecules.

190. (C) 1, 3 and 4 only
Heavy metals are generally defined by their high atomic weight or density. While some, like zinc and copper, are essential nutrients at low concentrations, they can become toxic at higher levels. Others, such as lead and mercury, serve no biological purpose and are hazardous even in small amounts. A primary mechanism of their toxicity involves binding to sulfhydryl groups on enzymes, which disrupts normal molecular functions. Understanding both roles is critical for managing health and environmental impacts.

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191. (A) Total inorganic carbon (TIC)
In water chemistry, total inorganic carbon represents the sum of all the different species of carbon found in an inorganic form. This includes dissolved carbon dioxide and carbonic acid, as well as the bicarbonate and carbonate ions. The relative proportions of these species are highly dependent on the pH of the water. Monitoring total inorganic carbon is essential for understanding the buffering capacity of natural waters and the role of aquatic systems in the global carbon cycle.

192. (B) It is composed of decaying plant and animal matter (humus).
The organic fraction of soil is composed primarily of decaying plant and animal matter at various stages of decomposition. This material, often referred to as humus, is a complex and stable substance that is essential for soil health. It provides a source of nutrients for plants and microorganisms, improves soil structure, and increases the soil's ability to retain moisture. Unlike inorganic mineral components derived from rocks, the organic portion is a product of biological activity and life.

193. (B) The hydroxyl radical (•OH)
The hydroxyl radical is widely recognized as the primary oxidizing agent responsible for the natural cleansing of the troposphere. Often

251. (B) To indicate the spontaneity of a chemical process.
Gibbs' energy serves as a fundamental thermodynamic indicator in environmental chemistry. A negative value for this parameter signifies that a chemical process can occur spontaneously without needing external energy input. This concept is essential for predicting whether reactions, such as the degradation of organic pollutants or neutralization of acid rain, are energetically feasible and spontaneous in natural environments.

252. (A) Chemical potential
Chemical potential represents the fundamental driving force for the movement and mass transfer of substances between distinct environmental compartments. This principle governs how gases like oxygen or carbon dioxide dissolve from the atmosphere into aquatic systems. It determines the direction and extent of mass transport until a state of equilibrium is reached across different environmental phases.

253. (C) not necessarily occur at a fast rate.
Thermodynamics only determines whether a chemical reaction is possible or spontaneous but does not define the speed of the process. Even if a reaction is thermodynamically favorable with a negative Gibbs' energy, it may proceed extremely slowly. The actual rate of reaction is governed by chemical kinetics, which can be significantly influenced by the presence of specific catalysts.

254. (D) The speed at which the reaction takes place.
Chemical kinetics focuses on the temporal aspects of chemical reactions, specifically measuring how fast they proceed. While thermodynamics predicts if a reaction can occur, kinetics identifies the reaction rate and the specific pathways involved. This study is crucial in environmental science for assessing the time required for pollutant degradation or the transformation of various chemical species over time.

255. (C) The dissolution of atmospheric gases in water.
The dissolution of gases like carbon dioxide and oxygen from the atmosphere into water bodies directly demonstrates the principle of chemical potential. This thermodynamic property acts as the driving force for mass transfer between different environmental compartments. It ensures that molecules move from areas of higher potential to lower potential until a stable chemical equilibrium is established.

256. (B) Bicarbonate ion (HCO_3^-)
The distribution of inorganic carbon species in water is strictly dependent on the pH level. In the neutral to slightly alkaline range typical of most natural waters, such as pH 7.5, the bicarbonate ion is the most dominant and abundant form. In contrast, acidic conditions favor dissolved carbon dioxide, while highly alkaline environments result in more carbonate ions.

257. (D) The dissolution of atmospheric CO_2 into water.
The formation of the aquatic carbonate system begins when atmospheric carbon dioxide dissolves into the water to form aqueous CO_2. This physical process is the precursor to the subsequent chemical reactions, including the hydration of carbon dioxide to form carbonic acid. Following this, the acid undergoes stepwise dissociation into bicarbonate and carbonate ions based on the water's pH.

258. (A) regulate and buffer the water's pH.
The carbonate system acts as the primary buffer in natural aquatic environments, maintaining a stable pH level. It resists drastic changes in acidity or alkalinity by neutralizing added acids through reactions with bicarbonate and carbonate ions. Similarly, it counters added bases with carbonic acid, providing a stable chemical environment necessary for the survival of sensitive aquatic organisms.

259. (C) Bicarbonate and carbonate ions
When acidic pollutants enter a water body, the carbonate system provides buffering capacity through specific neutralization reactions. The bicarbonate and carbonate ions present in the water react with the incoming hydrogen ions to minimize fluctuations in pH. This dynamic equilibrium allows the aquatic system to absorb acidity, protecting the ecosystem from the harmful effects of rapid pH changes.

260. (A) Water pH
The chemical speciation of the carbonate system, which includes dissolved carbon dioxide, carbonic acid, bicarbonate, and carbonate, is primarily

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difference makes unsaturated compounds much more chemically reactive, allowing them to participate easily in addition reactions. Both types play significant roles in atmospheric chemistry and diverse industrial processes.

201. (C) Flame Photometry
Flame photometry is the most suitable analytical technique for the rapid and quantitative analysis of alkali metals like sodium and potassium in water samples. The method works by introducing the sample into a flame, which excites the metal atoms and causes them to emit light at specific, characteristic wavelengths. By measuring the intensity of this emitted light, the concentration of each element can be precisely determined. This technique is widely used because of its speed and high sensitivity.

202. (A) Mass transfer or phase change
Chemical potential is a powerful thermodynamic concept that predicts the direction of several physical and chemical processes. It acts as a driving force for mass transfer, where substances naturally move from regions of higher chemical potential to regions of lower potential until equilibrium is achieved. This principle governs processes like the movement of pollutants through different environmental compartments and the transition of substances between solid, liquid, and gaseous phases. Understanding chemical potential is essential for environmental modeling.

203. (A) P-3, Q-1, R-4, S-2
Radioisotopes are used in many scientific and industrial applications based on their unique decay properties. Carbon-fourteen is essential for the radiometric dating of ancient organic materials, while Uranium-two thirty-five serves as a primary fuel source for nuclear reactors. Cobalt-sixty is a powerful gamma radiation source used for medical radiotherapy and sterilization. Radon-two twenty-two is a naturally occurring radioactive gas that can accumulate in buildings, acting as a significant indoor air pollutant. Each plays distinct environmental roles.

204. (B) High water solubility
Persistent organic pollutants are defined by several key traits that make them hazardous and difficult to manage in the environment. These include high persistence against natural degradation, the ability to bioaccumulate in fatty tissues, and the potential for long-range transport through the atmosphere. In contrast, high water solubility is not a typical characteristic of these substances. Most persistent organic pollutants are lipophilic and have low solubility in water, which contributes to their tendency to accumulate in ecosystems.

205. (C) SEM provides surface images; TEM provides internal structures.
Scanning electron microscopy and transmission electron microscopy are both powerful tools for high-resolution imaging, but they provide different types of information. SEM scans the surface of a sample with a beam of electrons to create detailed three-dimensional-like images of its topography and morphology. TEM, on the other hand, passes a beam of electrons through an extremely thin specimen, providing detailed images of its internal structure and atomic arrangements. Together, these techniques offer a comprehensive physical characterization.

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206. (D) Lines of water oxidation to O_2 and reduction to H_2.
In an Eh-pH diagram, the region of water stability is defined by the chemical conditions under which liquid water is thermodynamically stable. This region is bounded by two specific lines representing the oxidation of water to produce oxygen gas and the reduction of water to produce hydrogen gas. Outside of these boundaries, water will tend to break down into its component elements. Understanding this stability field is essential for predicting the behavior of diverse chemical species.

207. (A) The analyte is separated as a precipitate and weighed.
Gravimetric analysis is a classical quantitative analytical method based on the measurement of mass. The fundamental principle involves converting a dissolved analyte into an insoluble, pure solid compound through a chemical precipitation reaction. This precipitate is then carefully filtered, washed, dried, and weighed. By using the known stoichiometric relationship between the final weighed product and the original analyte, the concentration of the

and released over time, lead poses a persistent and significant health risk.

237. (C) Photosynthesis
In the global carbon cycle, several processes move carbon between the atmosphere and the terrestrial biosphere. While respiration, combustion, and decomposition all release carbon dioxide into the air, photosynthesis is the primary natural mechanism that removes it. During this process, green plants and algae use solar energy to convert atmospheric carbon dioxide and water into organic molecules like glucose. This sequestered carbon then becomes part of the plant's biomass, helping to regulate atmospheric concentrations and planetary climate.

238. (D) Chemical bonds and functional groups present.
Fourier-transform infrared spectroscopy is a powerful analytical tool that provides detailed information about the molecular composition of a sample. The primary information obtained from an FTIR spectrum is the identification of specific chemical bonds and functional groups present within the substance. By measuring the unique vibrational frequencies of these bonds, the technique creates a molecular fingerprint that allows scientists to identify various organic compounds. This information is essential for characterizing pollutants and studying the complex transformations in natural environments.

239. (A) The formation of both acid rain and photochemical smog.
Nitrogen oxides are a group of highly reactive gases that play a major role in several significant environmental problems. Their primary impact is their contribution to the formation of both acid rain and photochemical smog. In the atmosphere, nitrogen oxides react with water vapor to form nitric acid and participate in complex sunlight-driven reactions with organic compounds to produce ground-level ozone. These pollutants can damage forests and cause serious respiratory issues in humans. Managing NOx is essential.

240. (D) 1, 2, 3, and 4
Various water quality parameters provide essential information about the levels of purity and pollution in aquatic systems. Dissolved oxygen refers to the actual concentration of oxygen gas available in the water, while biochemical oxygen demand measures the oxygen consumed by microorganisms during the decomposition of organic matter. Chemical oxygen demand provides a measure of the total oxygen required for chemical oxidation. Generally, in a polluted sample, the COD value will be higher than the BOD measurement.

241. (B) Sulfur dioxide (SO2) and nitrogen oxides (NOx)
The formation of acid rain is a significant environmental issue primarily caused by the atmospheric oxidation of specific primary pollutants. Sulfur dioxide and nitrogen oxides, which are often emitted from fossil fuel combustion and industrial processes, are the two key precursors. Once in the air, these gases react with oxygen and water vapor to form sulfuric and nitric acids. These acids then fall to the ground in various forms of precipitation, leading to the acidification of soil.

242. (A) Transmittance of the sample
In UV-Visible spectrophotometry, the absorbance and transmittance of a sample are two related physical properties used to quantify the concentration of a chemical species. Specifically, the absorbance is logarithmically related to the transmittance of the light passing through the sample. While transmittance represents the fraction of light that successfully passes through, absorbance represents the amount that is blocked or taken up. Understanding this relationship is essential for using Beer-Lambert's law to accurately calculate concentrations in laboratory experiments.

243. (C) Neutral to slightly alkaline (pH 7-8.5)
The mobility and bioavailability of heavy metals in soil are significantly influenced by the pH level of the environment. Generally, these metals are most stable and least likely to move into the surrounding water or be absorbed by plants when the soil pH is in the neutral to slightly alkaline range. At lower pH levels, metals often become more soluble and toxic, increasing environmental risk. Therefore, maintaining a balanced pH is a common strategy in environmental management.

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Biogeochemical cycles describe the essential movement of elements through the Earth's systems. The nitrogen cycle is characterized by critical steps like fixation, nitrification, and denitrification. In contrast, the phosphorus cycle lacks a significant atmospheric phase, with its primary reservoir being sedimentary rocks. The carbon cycle is deeply influenced by both natural processes like photosynthesis and human activities like fossil fuel combustion. The sulfur cycle is also complex, involving significant transformations in both atmospheric and terrestrial environments.

216. (A) The classification of elements based on electron configuration.
The Aufbau principle and Hund's rule are fundamental concepts used to describe how electrons are arranged within an atom's orbitals. The Aufbau principle states that electrons fill the lowest energy orbitals first, while Hund's rule describes how they occupy degenerate orbitals with maximum total spin. These rules are essential for determining the electronic configuration of elements, which in turn explains their position in the periodic table and their chemical reactivity. Understanding these principles is critical for chemistry.

217. (C) Simultaneous multi-element analysis at low limits.
Inductively coupled plasma-mass spectrometry offers several significant advantages over traditional atomic absorption methods for heavy metal analysis. Its most notable feature is the ability to perform simultaneous multi-elemental analysis on a single sample, which greatly increases laboratory efficiency. Furthermore, mass spectrometry provides much lower detection limits, allowing for the quantification of trace elements at extremely low concentrations. These capabilities make it an essential tool for comprehensive environmental monitoring and for identifying diverse metallic pollutants in complex samples.

218. (A) Gas-to-particle conversion process.
The formation of inorganic particulate matter, such as ammonium sulfate, in the atmosphere is a prime example of a gas-to-particle conversion process. This occurs when gaseous precursors like sulfur dioxide are oxidized to form low-volatility sulfuric acid, which then reacts with gaseous ammonia. The resulting chemical products can then nucleate or condense onto existing particles to form solid or liquid aerosols. These transformations are significant because they contribute to the production of fine atmospheric particles and aerosols.

219. (D) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ in a closed container
A chemical equilibrium is a state where the forward and reverse reactions occur at equal rates, resulting in no net change in the concentrations of the species involved. The reaction between nitrogen and hydrogen gases to form ammonia in a closed container is a classic example of this dynamic state. Unlike reactions that go to completion or processes like radioactive decay, this reversible reaction reaches a balance where both reactants and products are present indefinitely. This is fundamental.

220. (A) 1, 2, 3, and 4 only
The Earth's atmosphere is a complex mixture of gases where nitrogen and oxygen are the most abundant. Oxygen is primarily a product of photosynthesis, while ozone serves a protective role in the stratosphere but acts as a harmful pollutant in the troposphere. Reactive species like ions and radicals are typically short-lived but drive essential chemical transformations. In contrast, saturated hydrocarbons are generally less reactive than their unsaturated counterparts. Understanding these diverse components is fundamental for modeling quality.

221. (C) 5 days at 20°C
The standard biochemical oxygen demand test is used to measure the amount of dissolved oxygen consumed by microorganisms while decomposing organic matter in a water sample. The test is typically conducted over a period of exactly five days at a constant temperature of twenty degrees Celsius. These specific conditions provide a consistent baseline for comparing organic pollution levels in different water bodies. A high value obtained from this test indicates that the water is heavily loaded.

222. (C) Statement I is true, but Statement II is false.
Chemical speciation refers to the different physical and chemical forms in which an

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substance can be calculated with high precision. This remains a standard for inorganic analysis.

208. (A) Both A and R are true and R is the correct explanation of A.
The hydroxyl radical has an exceptionally short lifetime in the troposphere, typically lasting only a fraction of a second. This is because it is an extremely reactive species that immediately attacks and reacts with almost any trace gas it encounters. These interactions initiate the oxidation and eventual removal of many pollutants, making the hydroxyl radical the primary cleansing agent of the lower atmosphere. Despite its transient nature, its continuous production by sunlight ensures it plays a constant role.

209. (B) Organochlorines
Organochlorines are a group of organic compounds containing at least one covalently bonded chlorine atom. This class of chemicals, which includes substances like the pesticide DDT and industrial polychlorinated biphenyls, is notorious for its extreme environmental persistence. Because they are highly lipophilic and resistant to degradation, they accumulate in the fatty tissues of organisms and biomagnify up the food chain. These properties have led to widespread contamination and significant health risks, resulting in strict regulations.

210. (A) Le Chatelier's Principle
Le Chatelier's principle is a fundamental rule in chemistry that describes how a system at equilibrium responds to external changes. It states that if a change in concentration, temperature, or pressure is applied to a system already in a state of chemical equilibrium, the system will shift its position to counteract and minimize the effect of that disturbance. This principle is essential for predicting the outcomes of industrial chemical processes and understanding natural system reactions.

211. (C) High-Performance Liquid Chromatography (HPLC)
High-performance liquid chromatography is an advanced analytical technique used to separate the components of a complex mixture. It utilizes a liquid mobile phase that is pumped under high pressure through a column containing a solid stationary phase, which typically consists of fine porous particles. The high pressure allows for faster and more efficient separation of chemical species based on their unique interactions with the stationary phase. This method is particularly effective for analyzing diverse non-volatile organic compounds.

212. (B) 1, 2, 3, 4
The phosphorus cycle describes the movement of phosphorus through the Earth's systems, primarily in the form of phosphate ions. The process begins with the physical and chemical weathering of rocks, which releases phosphates into the soil and water. These nutrients are then absorbed by plants and integrated into biological molecules. Animals obtain phosphorus by consuming plants or other animals. Finally, the decomposition of dead organisms by microorganisms returns the phosphates to the soil for recycling.

213. (C) High affinity for hemoglobin, displacing oxygen.
Carbon monoxide is a dangerous air pollutant whose primary toxic effect on humans is its ability to interfere with oxygen transport in the blood. It has a much higher affinity for hemoglobin than oxygen does, binding hundreds of times more strongly. When inhaled, carbon monoxide forms a stable complex called carboxyhemoglobin, which reduces the blood's capacity to carry life-sustaining oxygen to tissues and organs. Even at low concentrations, this deprivation can lead to serious health problems.

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214. (B) Mass-to-charge ratio
In mass spectrometry, the fundamental parameter used to separate and identify different molecules is the mass-to-charge ratio. The instrument works by ionizing chemical species and then using electrical or magnetic fields to manipulate their paths based on this specific ratio. Each type of ion will follow a unique trajectory, allowing it to be detected and recorded. This technique provides detailed information about molecular weight and structure, making it an essential tool for identifying complex environmental pollutants.

215. (B) 1, 3, and 4 only

type of pesticide specifically formulated to kill or inhibit the growth of fungi and their spores. These chemicals are widely used in agriculture to protect crops from various fungal diseases that can reduce yields. Understanding different pesticide types, such as herbicides and insecticides, is essential for safe pest management.

230. (B) On, above, and below the surface of the Earth.
The hydrological cycle, often called the water cycle, describes the continuous and complex movement of water throughout the entire Earth system. This global circulation includes water in all its forms, moving on the surface in rivers and oceans, above the surface as vapor and clouds in the atmosphere, and below the surface as groundwater. Driven primarily by solar energy and gravity, the cycle ensures that water is constantly recycled and redistributed, which is essential for life.

231. (D) Increasing the temperature generally increases the rate of reaction.
Chemical kinetics is the study of the rates of chemical processes and the factors that influence them. A fundamental principle in this field is that increasing the temperature of a system generally leads to a faster reaction rate. This occurs because higher temperatures provide molecules with more kinetic energy, increasing the frequency and energy of collisions between them. While catalysts can also speed up reactions by lowering activation energy, the temperature relationship remains one of the most important features.

232. (A) Quartz particles
Soil is composed of a mixture of organic and inorganic materials, each contributing to its overall health and structure. Organic components include humus, which is stable decomposed matter, as well as living organisms like bacteria and fungi, and plant roots. These materials are essential for nutrient cycling. In contrast, quartz particles are a common inorganic component of soil, derived from the physical and chemical weathering of rocks. Unlike the biological parts, quartz provides structural stability and is chemically inert.

233. (A) Both A and R are true and R is the correct explanation of A.
Water is frequently referred to as the universal solvent because of its exceptional ability to dissolve a wide variety of substances. This unique characteristic is a direct result of its polar molecular structure and its ability to form strong hydrogen bonds. These properties allow water molecules to effectively attract and surround both ionic compounds and other polar molecules, pulling them into solution. This powerful solvent action is fundamental to most biological and environmental processes, making water essential for life.

234. (A) Mass-to-charge ratio and electric field strength.
In electrophoresis, the rate at which a charged molecule or particle migrates through a solution is determined by several key factors. The primary influences are the particle's own mass-to-charge ratio and the strength of the external electric field applied to the system. Molecules with a higher charge and lower mass will typically move more quickly toward the electrode of opposite charge. This principle allows for effective separation of complex mixtures of organic species, such as proteins.

235. (D) Secondary pollutant
Peroxyacetyl nitrate is a well-known and hazardous component of photochemical smog. It is classified as a secondary pollutant because it is not emitted directly from any source like cars or factories. Instead, it forms in the atmosphere through complex chemical reactions between primary pollutants, such as nitrogen oxides and volatile organic compounds, in the presence of sunlight. Because it is relatively stable at lower temperatures, it can be transported over long distances, spreading the negative impacts of pollution.

236. (B) Displace essential metals like calcium and zinc from enzymes.
The biochemical toxicity of lead is primarily due to its ability to mimic and displace essential divalent metals within the body. Lead atoms can interfere with various biological processes by taking the place of calcium and zinc in enzymes and other proteins. This displacement can disrupt critical functions, particularly in the nervous system, where it interferes with neurotransmission and development. Because it can be stored in bones

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called the atmospheric detergent, it initiates the chemical breakdown and removal of many different pollutants and trace gases, including methane and various volatile organic compounds. Although it is present in low concentrations and has a very short lifetime, its high reactivity makes it essential for maintaining air quality. Its formation is driven primarily by solar radiation.

194. (A) Intermediate between those of metals and non-metals.
Metalloids are a unique group of chemical elements that exhibit properties intermediate between those of metals and non-metals. This dual nature makes them particularly important in both environmental chemistry and technology. For example, elements like arsenic and selenium can behave like metals in some chemical reactions while showing non-metallic characteristics in others. This variation significantly influences their behavior, toxicity, and mobility in soil and water. Understanding these properties is essential for predicting the environmental fate of pollutants.

195. (A) 1, 2, 3, and 5 only
Water treatment involves several coordinated stages to ensure the removal of different types of impurities. Sedimentation utilizes gravity to remove dense solids, while filtration provides a physical barrier for suspended particles. Coagulation is a chemical process that uses specific agents to destabilize fine colloidal matter. Maintaining the correct pH is often essential for these chemical reactions to occur efficiently. In contrast, flocculation requires gentle mixing to promote particle growth, rather than the vigorous mixing described in alternatives.

196. (D) Identify unknown organic compounds by their functional groups.
Fourier-transform infrared spectroscopy is a versatile tool in environmental analysis, primarily used for the identification of unknown organic compounds. The technique works by measuring the absorption of infrared radiation, which causes chemical bonds to vibrate at characteristic frequencies. These vibrations appear as specific peaks in the resulting spectrum, allowing scientists to identify the functional groups and molecular structure of various chemical species. This information is essential for monitoring pollution sources and characterizing complex organic matter in soil.

197. (C) Nitrification
Nitrification is a vital biological step in the nitrogen cycle where ammonia is converted into nitrate through the intermediate stage of nitrite. This process is primarily carried out by two groups of specialized aerobic bacteria. The first group oxidizes ammonia to nitrite, and the second group further oxidizes the nitrite into nitrate. This transformation is essential because it makes nitrogen available in a form that plants can easily absorb. Understanding nitrification is critical for nitrogen management.

198. (B) A color change of an indicator.
In a titration, the end point is the physical change that indicates the reaction between the analyte and the titrant is complete. This is typically observed through a noticeable color change of an indicator substance added to the sample before the experiment begins. The choice of indicator depends on the type of reaction being performed, such as acid-base or redox. Identifying the end point accurately is essential for calculating the unknown concentration with high precision and reliability.

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199. (D) NOx, VOCs, and sunlight
The formation of photochemical smog is a complex atmospheric process that requires three fundamental ingredients. Nitrogen oxides and volatile organic compounds are the primary pollutants, often originating from vehicle exhaust and industrial emissions. Sunlight provides the necessary energy to drive the chemical reactions between these precursors. This interaction leads to the production of harmful secondary pollutants like ground-level ozone and peroxyacetyl nitrate. Understanding these main components is essential for developing effective strategies to reduce urban pollution.

200. (A) Both Statement I and Statement II are true.
Hydrocarbons are classified based on the nature of the chemical bonds between carbon atoms. Saturated hydrocarbons, also known as alkanes, contain only single covalent bonds and are generally less reactive. In contrast, unsaturated hydrocarbons like alkenes and alkynes possess at least one double or triple bond. This structural

244. (D) The window between the essential nutritional requirement and toxic levels is very narrow.
The biochemical behavior of selenium is particularly challenging to manage in the environment because of the very narrow window between its essential nutritional requirement and its toxic levels. At low concentrations, selenium is a vital micronutrient necessary for the function of important antioxidant enzymes. However, if levels rise only slightly above this range, it becomes highly toxic to both humans and wildlife, causing severe health problems. This delicate balance makes selenium a significant concern for environmental monitoring.

245. (B) 1, 2, 3, and 5 only
Analytical spectroscopy encompasses a wide range of techniques that use the interaction of radiation with matter to identify and quantify chemical species. Atomic absorption spectrophotometry, inductively coupled plasma-mass spectrometry, Fourier-transform infrared spectroscopy, and X-ray fluorescence are all examples of these methods. Each technique utilizes a different part of the spectrum to provide specific information about a sample's elemental or molecular composition. In contrast, methods like titrimetry are based on chemical reactions and diverse analytical volume measurements.

246. (B) To select a narrow wavelength band of light from a broad-spectrum source.
In a spectrophotometer, the monochromator serves a critical role in the optical system. Its primary function is to receive a broad spectrum of light from the instrument's source and select a very narrow, specific wavelength band to pass through the sample. This process is essential for ensuring that the measurement follows Beer-Lambert's law, which requires monochromatic light for accurate results. By isolating the correct wavelength, the monochromator allows the instrument to precisely detect and quantify specific chemical species.

247. (D) Bonds in saturated vs unsaturated ones.
The fundamental difference in chemical reactivity between saturated and unsaturated hydrocarbons is due to the nature of the covalent bonds between their carbon atoms. Saturated hydrocarbons, or alkanes, possess only single bonds, which are strong and relatively unreactive under normal conditions. In contrast, unsaturated hydrocarbons like alkenes and alkynes contain at least one double or triple bond. These multiple bonds are areas of high electron density and are more easily broken, allowing the molecules to react easily.

248. (A) Tendency of a system to oxidize or reduce a species.
The redox potential, often denoted as Eh, is a quantitative thermodynamic parameter that measures the tendency of a chemical system to either oxidize or reduce a specific chemical species. It provides essential information about the electron-donating or electron-accepting capacity of an environment. High positive values indicate a strong oxidizing environment, while negative values signify a reducing environment. Monitoring redox potential is fundamental for predicting the stability, mobility, and toxicity of various pollutants in complex aquatic systems.

249. (C) $\Delta G = \Delta H - T\Delta S$
The relationship between the three fundamental thermodynamic parameters—Gibbs free energy, enthalpy, and entropy—is defined by a specific equation. The change in Gibbs free energy for a process at constant temperature is equal to the change in enthalpy minus the product of the absolute temperature and the change in entropy. This equation is essential for predicting the spontaneity of chemical and physical transformations. If the resulting change in Gibbs energy is negative, the process is thermodynamically favorable.

250. (A) Nuclear Magnetic Resonance (NMR) Spectroscopy
Nuclear magnetic resonance spectroscopy is the most suitable analytical technique for the definitive identification and characterization of complex organic molecular structures. The method works by measuring the interaction of specific atomic nuclei with a strong magnetic field and radiofrequency radiation. The resulting spectrum provides detailed information about the chemical environment and connectivity of atoms within a molecule. This technique is indispensable for identifying unknown pollutants and studying the complex chemical species found in various natural environmental samples.

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element can exist within a system. This concept is vital for environmental science because the toxicity, mobility, and bioavailability of elements like chromium and arsenic are highly dependent on their specific form. For example, different oxidation states of the same metal can exhibit vastly different health risks and environmental behaviors. Therefore, the common assumption that toxicity is independent of speciation is incorrect for risk assessment.

223. (A) Ingestion of seafood contaminated with methylmercury.
Minamata disease is a severe and debilitating neurological condition caused by the ingestion of seafood contaminated with methylmercury. This toxic organic compound was historically released into the marine environment through industrial wastewater, where it then entered the food chain and biomagnified in local fish and shellfish populations. Humans who consumed large quantities of these contaminated seafood products suffered from serious health issues, including loss of coordination and cognitive impairment. This tragic event remains a landmark in history.

224. (B) The concentration of dissolved aqueous CO2.
In the context of the carbonate system in water, Henry's Law constant is a critical parameter that describes the equilibrium partitioning of carbon dioxide between the air and the water. It specifically relates the partial pressure of carbon dioxide in the atmosphere to the concentration of the dissolved aqueous gas in the water. This relationship is essential for calculating how much carbon dioxide will enter or leave water bodies under different conditions. It regulates the pH capacity.

225. (B) The input or release of heat.
A thermochemical reaction is a chemical process that is principally governed by the exchange of thermal energy. Unlike photochemical reactions, which are triggered by light, or biological processes driven by enzymes, thermochemical reactions depend on heat energy to overcome the activation energy barrier. These reactions can either release heat into the surroundings, known as exothermic processes, or absorb heat from them, known as endothermic ones. Temperature is the primary factor influencing the rate and direction.

226. (A) Change in temperature
A bomb calorimeter is a specialized device used in thermodynamics to determine the energy content of a substance by measuring its heat of combustion. The fundamental measurement taken during this process is the change in temperature of the surrounding water bath. When a sample is burned inside the sealed, high-pressure container, the released heat energy is transferred to the water, causing its temperature to rise. By accurately measuring this increase, scientists can calculate the total energy released.

227. (C) The incomplete combustion of fossil fuels and biomass
Polycyclic aromatic hydrocarbons are a large group of organic compounds produced primarily through the incomplete combustion of fossil fuels, wood, and other organic materials. They are common air pollutants in urban environments, often associated with vehicle exhaust, residential heating, and industrial processes. Many of these compounds are known carcinogens and pose significant long-term health risks upon inhalation. Identifying their sources and understanding their behavior is essential for developing effective air quality regulations and protection.

228. (B) P-4, Q-3, R-1, S-2
Different analytical techniques are chosen based on the specific type of information needed about a sample. Gas chromatography-mass spectrometry is the primary tool for identifying and quantifying volatile organic compounds. Scanning electron microscopy is used for imaging the surface morphology and topography of solids. X-ray diffraction is essential for determining the internal crystal structure of solid materials. Atomic absorption spectrophotometry is a standard method for quantifying specific metallic elements in liquid samples. Together, these methods provide characterization.

229. (C) Fungicide
Pesticides are a broad category of chemicals designed to control or eliminate organisms considered pests, and they are further classified based on their specific targets. A fungicide is a

controlled by the pH of the water. Variations in hydrogen ion concentration determine which species will be dominant. Acidic conditions favor dissolved gases and carbonic acid, whereas neutral and alkaline conditions lead to higher concentrations of bicarbonate and carbonate.

261. (D) It helps understand the reactivity and transport of airborne substances.
Chemical speciation refers to the specific distribution of an element among different chemical forms or species. Understanding these specific forms is essential for predicting how substances behave in the atmosphere, including their reactivity, transport mechanisms, and potential toxicity. It provides a more detailed picture of environmental impact than simply measuring the total mass or concentration of an element.

262. (B) a gas-to-particle conversion process for inorganic matter.
The creation of ammonium sulfate and ammonium nitrate in the atmosphere is a classic example of gas-to-particle conversion. This inorganic process occurs when gaseous precursors like sulfur dioxide and nitrogen oxides are oxidized to form acids. These acids subsequently react with ammonia gas to produce fine solid particles, illustrating how gas-phase pollutants can transform into secondary particulate matter.

263. (C) Photochemical reactions initiated by solar radiation.
Daytime oxidation of atmospheric pollutants is primarily driven by photochemical reactions triggered by solar radiation. These light-induced processes generate highly reactive species, such as the hydroxyl radical, which initiate the breakdown and transformation of various pollutants. While thermochemical reactions can occur without light, the influx of solar energy during the day significantly accelerates the oxidation of atmospheric compounds.

264. (D) The atmospheric oxidation of volatile organic compounds.
Secondary organic aerosols are formed through the atmospheric oxidation of volatile organic compounds. During this process, VOCs react with oxidants to create products with low volatility. These newly formed compounds then condense or nucleate to form fine particles. This transformation highlights the transition of carbon-based gases into solid or liquid organic particulate matter within the Earth's atmosphere.

265. (A) They are highly reactive species that drive oxidation processes.
Hydroxyl radicals are characterized by their extreme reactivity and serve as the primary oxidants in the Earth's atmosphere. They are instrumental in initiating the chemical breakdown of numerous pollutants, including volatile organic compounds and inorganic gases. By driving these oxidation cycles, these radicals play a central role in regulating the lifespan and concentration of various substances in the air.

266. (B) The photodissociation of molecular oxygen by UV radiation.
The Chapman cycle defines the natural process of ozone formation in the stratosphere, beginning with the photodissociation of molecular oxygen. High-energy ultraviolet radiation, with wavelengths shorter than 242 nanometers, splits an oxygen molecule into two reactive oxygen atoms. These individual atoms then react with other oxygen molecules to produce ozone, establishing the foundation of the protective ozone layer.

267. (B) Stratospheric ozone is beneficial by absorbing UV, while tropospheric ozone is a pollutant.
Ozone's environmental impact depends entirely on its location in the atmosphere. In the stratosphere, it forms a vital shield that protects the Earth's surface by absorbing harmful solar ultraviolet radiation. Conversely, when ozone is present in the troposphere, it acts as a harmful pollutant and a major component of smog, causing damage to human health and various ecosystems.

268. (A) They act as catalysts in the photochemical formation of tropospheric ozone.
Nitrogen oxides and volatile organic compounds are essential precursors for the formation of ozone in the troposphere. Through a series of complex photochemical reactions powered by sunlight, these substances interact to generate ozone as a secondary pollutant. Unlike the oxygen-only Chapman cycle in the stratosphere, tropospheric ozone production is heavily reliant

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40. Consider the following statements regarding biodiversity:
I. Biodiversity is important for ecosystem stability and productivity.
II. Threats to biodiversity include habitat loss, pollution, and climate change.
III. The Western Ghats is a recognized biodiversity hotspot in India.
IV. High biodiversity is generally a feature of polar regions.
Which of the above statements are correct?
(A) I and II only
(B) I, II, and III only
(C) III and IV only
(D) I, II, III, and IV

41. Which of the following is an example of an in situ conservation strategy?
(A) A botanical garden
(B) A seed bank
(C) A national park
(D) A zoological park

42. Ex situ conservation refers to the conservation of biodiversity:
(A) Outside the natural habitat of the species.
(B) Within the natural habitat of the species.
(C) Only through legislative measures.
(D) By focusing exclusively on keystone species.

43. Which of the following is specifically defined as a protected area designated for the conservation of wildlife, where activities like forestry and grazing may be permitted to an extent?
(A) National Park
(B) Biosphere Reserve
(C) Sacred Grove
(D) Sanctuary

44. 'Sacred groves' in India are examples of:
(A) Ex situ conservation managed by the central government.
(B) In situ conservation protected by local communities.
(C) A modern concept of global restoration ecology.
(D) Areas designated for bioprospecting by corporations.

45. The complete set of unique alleles in a species or population is referred to as its:
(A) Genome
(B) Genotype
(C) Gene pool
(D) Gene flow

46. The practice of commercially exploiting naturally occurring biochemical or genetic material, often without fair compensation to the communities of origin, is known as:
(A) Bio-prospecting
(B) Bioremediation
(C) Bio-fortification
(D) Biopiracy

47. Read the following statements regarding restoration ecology and select the correct option.
Statement I : Restoration ecology is the practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats.
Statement II : The primary goal of restoration ecology is to introduce commercially valuable species into a degraded area.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

48. A species that is facing an extremely high risk of extinction in the wild in the immediate future is categorized as:
(A) Rare
(B) Endangered
(C) Threatened
(D) Extinct

49. The core concept of 'Industrial Ecology' is to:
(A) Separate industrial zones completely from natural ecosystems.
(B) Model industrial systems on natural ecological cycles.
(C) Study the ecological impact of industrial pollution.
(D) Promote the rapid industrialization of undeveloped areas.

50. The process by which a toxic agent enters the body is known as:
(A) Absorption
(B) Distribution
(C) Excretion
(D) Biotransformation

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heavier clusters known as flocs. These larger masses are much easier to remove during subsequent sedimentation and filtration stages. This physical step is essential for effectively clearing fine suspended solids and pollutants.

278. (B) potential for oxidation or reduction reactions.
The Redox potential of an aquatic system indicates its overall tendency to gain or lose electrons, reflecting the potential for oxidation or reduction reactions. High values signify oxidizing environments, while low values indicate reducing conditions. This parameter is critical for understanding the chemical speciation, solubility, and mobility of various elements and pollutants within the water body and sediments.

279. (C) Coagulation → Flocculation → Filtration
The effective removal of fine suspended particles from water follows a specific sequence of chemical and physical treatments. First, coagulation neutralizes particle charges. Second, flocculation uses gentle mixing to aggregate these particles into larger flocs. Finally, filtration provides a physical barrier to trap and remove the remaining solids and flocs. This structured approach ensures the maximum clarity of treated water.

280. (D) highly reducing conditions.
A low Redox potential value characterizes a water system as having highly reducing conditions. In such environments, chemical species are more likely to gain electrons, which significantly influences the types of chemical reactions that occur. Reducing conditions often exist in environments with low dissolved oxygen, such as deep sediments or stagnant waters, affecting the chemical form of various pollutants.

281. (A) The weathering of parent rock material.
The inorganic fraction of soil is formed through the physical and chemical weathering of parent rock material over long periods. This process breaks down rocks into smaller mineral particles such as quartz, feldspars, and clays. These minerals provide the essential structural framework for the soil and serve as a long-term reservoir for various nutrients required by plants and microbes.

282. (B) Denitrification
Denitrification is a microbial process within the nitrogen cycle that involves the reduction of nitrate back into gaseous nitrogen. This step typically occurs under anaerobic conditions, where specific bacteria use nitrate as an electron acceptor. By converting liquid-phase nitrogen back into atmospheric gas, denitrification completes the cycle and helps regulate the availability of nitrogen in various environmental compartments.

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283. (B) To improve soil structure, water retention, and nutrient supply.
Soil organic matter, derived from the decomposition of plant and animal remains, is vital for maintaining soil health and productivity. It enhances the soil's physical structure, increases its capacity to retain water, and serves as a critical source of essential nutrients. Additionally, SOM supports a diverse community of soil organisms, which are necessary for efficient nutrient cycling and ecosystem health.

284. (A) Whether the soil acts as a source or sink for atmospheric CO_2.
The carbon cycle in soils is defined by the net balance between carbon added through photosynthesis and carbon lost through decomposition and respiration. This balance determines if the soil functions as a carbon sink, storing more carbon than it releases, or a carbon source, contributing to atmospheric carbon dioxide levels. This function is a critical component of global climate regulation.

285. (C) Nitrification
Nitrification is a two-step biological process in the nitrogen cycle where ammonia is oxidized into nitrate. This transformation is carried out by specialized soil bacteria and is essential for converting nitrogen into a form that is easily absorbed by plants. As a key part of the biogeochemical cycling of nitrogen, nitrification influences soil fertility and nitrogen leaching into groundwater.

286. (D) bind to and disrupt the function of proteins and enzymes.
The biochemical toxicity of heavy metals like lead and mercury is primarily due to their high affinity for sulfur-containing groups in biological molecules. They bind to essential proteins

on these specific anthropogenic and natural chemical inputs.

269. (C) The cycle of ozone formation and destruction in the stratosphere.
The continuous cycle of ozone formation and destruction in the stratosphere, known as the Chapman cycle, effectively absorbs the majority of harmful solar ultraviolet radiation. This process involves the repeated photodissociation of oxygen and ozone molecules. By capturing this high-energy radiation, the stratospheric ozone layer prevents it from reaching the Earth's surface, thereby protecting biological organisms from DNA damage.

270. (D) Tropospheric ozone
Tropospheric ozone is the primary and most significant constituent of photochemical smog. It is formed near the Earth's surface through complex reactions between nitrogen oxides and volatile organic compounds in the presence of sunlight. While ozone in the upper atmosphere is beneficial, its presence at ground level creates a toxic environment that contributes to respiratory issues and environmental degradation.

271. (C) Its capacity as a universal solvent.
Water's ability to act as a universal solvent is its most significant property within the hydrological cycle. This characteristic allows it to dissolve and transport an extensive range of minerals, nutrients, and pollutants across different environmental compartments. By facilitating the movement of these substances, water plays a critical role in global biogeochemical processes and the overall maintenance of ecosystems.

272. (B) The concentration of biodegradable organic pollution.
Biochemical Oxygen Demand provides an indirect measurement of the concentration of biodegradable organic pollution in a water sample. It quantifies the amount of dissolved oxygen consumed by aerobic microorganisms as they decompose organic matter over a specific period. This parameter is a vital indicator of water quality, reflecting the extent of organic loading that can be biologically degraded.

273. (D) The COD value is typically higher than the BOD value.
Chemical Oxygen Demand generally yields a higher value than Biochemical Oxygen Demand for the same water sample. This occurs because COD measures the oxygen required to chemically oxidize all organic matter, including both biodegradable and non-biodegradable substances. BOD only accounts for the oxygen used during biological degradation, which typically involves only a subset of the total organic material.

274. (A) the introduction of oxygen-demanding pollutants.
A rapid decline in Dissolved Oxygen levels often indicates the introduction of oxygen-demanding pollutants into a water body. These pollutants, usually organic in nature, stimulate the growth of aerobic bacteria that consume dissolved oxygen during the decomposition process. This depletion of oxygen can lead to hypoxic conditions, severely threatening the survival of fish and other sensitive aquatic organisms.

275. (C) COD measures both biodegradable and non-biodegradable organics, while BOD measures mainly biodegradable organics.
The distinction between BOD and COD lies in the scope of organic matter they measure. BOD focuses primarily on biodegradable organic substances that microorganisms can break down. In contrast, COD uses a strong chemical oxidant to measure both biodegradable and chemically oxidizable non-biodegradable organic matter. Therefore, COD provides a more comprehensive assessment of the total organic pollution levels.

276. (A) To neutralize the charge on colloidal particles.
Adding chemicals like alum during the coagulation phase of water treatment serves to neutralize the negative surface charges on colloidal particles. These small particles normally repel each other, preventing them from settling. By neutralizing these charges, coagulation allows the particles to come closer together and begin clumping, which is a necessary step for their eventual removal from water.

277. (D) Flocculation
Flocculation is the process of gentle mixing that follows coagulation in water treatment. Its primary purpose is to encourage destabilized particles to collide and aggregate into larger,

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organic compounds, and polycyclic aromatic hydrocarbons. These substances can originate from vehicle exhaust, industrial processes, and smoke, posing a significant long-term risk to health by inducing mutations.

296. (D) The separation of analytes based on their differential partitioning between two phases.
Chromatographic techniques like Gas Chromatography and High-Performance Liquid Chromatography are based on the differential partitioning of substances between a mobile phase and a stationary phase. As the sample moves through the system, different components interact with the stationary phase to varying degrees. This causes them to travel at different speeds, leading to their effective separation based on specific chemical properties.

297. (A) Fourier-Transform Infrared Spectroscopy (FTIR)
Fourier-Transform Infrared Spectroscopy is the most suitable technique for identifying functional groups within organic molecules. It works by measuring the absorption of infrared radiation, which causes characteristic vibrations in chemical bonds. Each functional group absorbs specific frequencies of light, creating a unique spectral fingerprint. This allows researchers to definitively determine the chemical structure and identify various functional groups in a sample.

298. (B) The interaction of electromagnetic radiation with matter.
Spectrophotometric and spectrometric techniques such as UV-VIS, Atomic Absorption Spectrophotometry, and ICP-AES are all based on the interaction between electromagnetic radiation and matter. These methods measure how much light a sample absorbs or emits at specific wavelengths. These interactions correspond to electronic transitions in atoms or molecules, providing a highly sensitive and specific way to quantify concentrations of various elements.

299. (B) It combines a separation method with a detection method for definitive identification.
Hyphenated techniques like Gas Chromatography-Mass Spectrometry provide a powerful advantage by combining the separation capabilities of one method with the identification strengths of another. The GC component first separates the individual components of a complex mixture. Then, the mass spectrometer provides a unique mass spectrum for each separated compound, allowing for the definitive identification of unknown substances with high precision.

300. (A) SEM and XRF
To determine both the surface morphology and the elemental composition of particulate matter, a combination of Scanning Electron Microscopy and X-ray Fluorescence is ideal. SEM uses an electron beam to create high-resolution images of a sample's surface structure. Meanwhile, XRF measures the characteristic X-rays emitted from a sample when excited, allowing for the precise identification and quantification of chemical elements.

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and enzymes, causing structural changes that inhibit their normal functions. This interference at the molecular level disrupts vital cellular processes, leading to the severe physiological and neurological damage associated with metal poisoning.

287. (C) Methylmercury
Methylmercury is a highly toxic organic form of mercury that is particularly dangerous because of its ability to biomagnify in aquatic food webs. As it moves up the food chain, its concentration increases significantly in the tissues of predatory fish. This potent neurotoxin can cause severe damage to the central nervous system in humans and wildlife, even at low exposures.

288. (B) carcinogenic properties.
Hexavalent chromium is widely recognized for its potent carcinogenic properties. Unlike other forms of chromium, Cr(VI) can easily enter living cells, where it undergoes reduction and causes significant damage to DNA and cellular proteins. This genetic damage can lead to the development of various cancers, making it a major concern in industrial settings and contaminated environmental site locations.

289. (D) The toxicity of a chemical can be dose-dependent.
Selenium serves as a classic example of the dose-dependent nature of chemical toxicity. While it is an essential micronutrient required for healthy biological functioning at low concentrations, it becomes highly toxic when levels exceed a certain threshold. This transition from being beneficial to harmful highlights the importance of concentration and exposure levels in determining the toxicological impact of environmental substances.

290. (A) Cadmium (Cd)
Cadmium is a heavy metal known for its long half-life in the human body and its tendency to accumulate in the kidneys. Chronic exposure to cadmium can lead to renal dysfunction and is also associated with significant skeletal damage, including bone mineralization defects and increased fragility. This specific toxicological profile makes cadmium a serious environmental and health hazard in many regions.

291. (C) It impairs the transport of oxygen in the blood.
Carbon monoxide exerts its toxic effects by binding to hemoglobin in the blood with a much higher affinity than oxygen. This results in the formation of carboxyhemoglobin, which significantly reduces the blood's ability to transport oxygen to vital organs and tissues. This oxygen deprivation can lead to symptoms ranging from headaches and dizziness to severe neurological damage or even death.

292. (A) Resistance to degradation, bioaccumulation, and long-range transport.
Persistent Organic Pollutants are defined by a specific set of hazardous properties. They are highly resistant to environmental degradation, allowing them to persist for long periods. They are also lipophilic, meaning they bioaccumulate in the fatty tissues of living organisms. Furthermore, their stability and physical properties enable them to be transported across long distances, often reaching remote Arctic regions.

293. (D) Peroxyacetyl Nitrate (PAN)
Peroxyacetyl Nitrate is a secondary pollutant formed in the atmosphere through photochemical reactions involving nitrogen oxides and volatile organic compounds. It is a major component of photochemical smog and is well-known for being a potent eye and respiratory irritant. Additionally, PAN is highly phytotoxic, meaning it can cause significant damage to plant tissues and reduce crop yields in affected areas.

294. (B) Being directly toxic and acting as precursors to secondary pollutants.
Volatile Organic Compounds play a dual role in environmental pollution. Many VOCs are directly toxic or irritating to humans and animals upon inhalation. Simultaneously, they act as critical chemical precursors in the atmosphere. In the presence of sunlight and nitrogen oxides, VOCs undergo complex reactions that lead to the formation of secondary pollutants like ozone and peroxyacetyl nitrate pollutants.

295. (C) Carcinogen.
Any substance capable of causing cancer in living tissue is classified as a carcinogen. In the context of air pollution, this category includes a variety of compounds such as benzene, certain volatile

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9. Read the following statements and select the correct option.
Statement I : Primary succession occurs in an area that has been previously occupied by a living community but was disturbed or removed.
Statement II : Secondary succession begins on a lifeless area where there is no soil, such as a bare rock.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

10. Which concept describes the number of different species present in an ecosystem and the relative abundance of each of those species?
(A) Species diversity
(B) Ecotone
(C) Edge effect
(D) Ecological niche

11. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The transitional zone between two adjacent ecosystems, known as an ecotone, often exhibits high species diversity.
Reason (R) : An ecotone contains species from both adjoining communities as well as species specifically adapted to the ecotone itself.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

12. The functional role and position of a species in its ecosystem, including what it eats and what eats it, is defined as its:
(A) Ecological habitat
(B) Ecological niche
(C) Trophic level
(D) Biome

13. Which of the following factors does NOT typically contribute to ecosystem stability?
(A) High species diversity
(B) Complex food webs
(C) Regular and severe disturbances
(D) Presence of keystone species

14. Match List I with List II by selecting the correct pairing of ecosystem services and examples.
List I: (Ecosystem Service)
P. Provisioning Service
Q. Regulating Service
R. Cultural Service
S. Supporting Service
List II: (Example)
1. Climate regulation
2. Food and water
3. Nutrient cycling
4. Recreation and aesthetic value
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-3, R-4, S-1

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15. What is the primary basis for the classification of ecosystems?
(A) Geographic location and dominant life forms.
(B) The number of producers and consumers.
(C) The age and geological history of the system.
(D) The level of direct human intervention.

16. A hot desert ecosystem is primarily characterized by:
(A) Low temperatures and high humidity.
(B) High temperatures and low precipitation.
(C) Permafrost and sparse vegetation.
(D) Abundant rainfall and dense canopy.

17. Which of the following is an example of a lentic ecosystem?
(A) A river
(B) A lake
(C) A stream
(D) An estuary

18. Consider the following characteristics:
I. Brackish water environment
II. High salt tolerance in flora (halophytes)
III. Serves as a nursery for many marine species
IV. Typically found at the interface of rivers and the ocean
Which type of ecosystem do these characteristics best describe?
(A) Oceanic
(B) Lotic
(C) Estuarine (Mangrove)
(D) Cold Desert

19. The vast, open ocean, characterized by deep water and pelagic organisms, is classified as which type of ecosystem?
(A) Lentic
(B) Lotic
(C) Oceanic
(D) Estuarine

20. A biome is best defined as:
(A) A small community of interacting organisms.
(B) The specific physical location where an organism lives.
(C) A transitional zone between two different ecosystems.
(D) A large area defined by climate and distinct communities.

21. Which of the following biomes is characterized by permafrost, low-growing vegetation like mosses and lichens, and extremely cold temperatures?
(A) Taiga
(B) Savanna
(C) Tundra
(D) Deciduous forest

22. The Taiga biome, also known as the boreal forest, is dominated by:
(A) Broad-leaved deciduous trees.
(B) Coniferous trees like pine, spruce, and fir.
(C) Cacti and succulent plants.
(D) Tall grasses and scattered trees.

23. Which of the following statements about the Tropical Rain Forest biome is incorrect?
(A) It has high annual rainfall.
(B) It exhibits the highest biodiversity among terrestrial biomes.
(C) It has a dense, multi-layered canopy.
(D) The soil is extremely rich in nutrients.

24. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Deciduous Forest Biome is characterized by trees that shed their leaves seasonally.
Reason (R) : This adaptation helps the trees to conserve water and energy during cold or dry seasons.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

25. The Savanna biome is best described as:
(A) A dense forest with high rainfall.
(B) A cold, treeless plain with permafrost.
(C) A grassland with scattered trees and wet/dry seasons.
(D) A mountainous region with permanent ice and snow.

26. Which one of the following is a characteristic of a population?
(A) Population density
(B) Species diversity
(C) Energy flow
(D) Stratification

27. Consider the following statements about population characteristics:
I. Natality refers to the death rate of individuals in a population.
II. Population dispersion describes the spatial pattern of individuals.
III. Carrying capacity is the maximum number of individuals an environment can support.
IV. Age structure is not a characteristic of a population.
V. A metapopulation is a single, isolated population.
Which of the above statements are correct?
(A) I and IV only
(B) II and III only
(C) I, II and V only
(D) II, III and V only

28. The concept of 'carrying capacity' (K) is central to which model of population growth?
(A) Exponential growth model
(B) Logistic growth model
(C) Geometric growth model
(D) Static population model

29. A species with a high intrinsic rate of increase ('r'), short life span, and rapid development, which colonizes new environments quickly, is referred to as:

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(A) A 'k' species
(B) A keystone species
(C) An 'r' species
(D) An endemic species

30. Which of the following is the best example of a 'k' selected species?
(A) Bacteria
(B) Mosquito
(C) Dandelion
(D) Elephant

31. Match List I with List II by selecting the correct pairing of population concepts and descriptions.
List I: (Population Concept)
P. Metapopulation
Q. Dispersion
R. Carrying Capacity (K)
S. 'r' species
List II: (Description)
1. Maximum sustainable population size
2. Spatial arrangement of individuals
3. A network of semi-isolated populations with migration between them
4. Opportunistic species with high growth rate
(A) P-3, Q-2, R-1, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

32. What is a keystone species?
(A) The most abundant species in a community.
(B) A species with high impact relative to its abundance.
(C) A non-native species that disrupts the local ecosystem.
(D) A species at the top of the food chain with no predators.

33. Which of the following represents a '+' / '-' interaction between two species?
(A) Mutualism
(B) Predation
(C) Commensalism
(D) Competition

34. The ecological interaction where one organism benefits by living on or in another organism (the host), which is harmed in the process, is called:
(A) Parasitism
(B) Predation
(C) Allelopathy
(D) Herbivory

35. The production and release of biochemicals by one plant species that inhibit the growth, survival, or reproduction of other nearby plants is known as:
(A) Herbivory
(B) Predation
(C) Allelopathy
(D) Commensalism

36. Arrange the following major events in the history of life on Earth in chronological order:
I. Origin of life
II. Origin of eukaryotic cells
III. Speciation leading to modern humans
IV. Colonization of land by plants and animals
Which of the following is the correct sequence?
(A) I, III, II, IV
(B) I, II, IV, III
(C) II, I, IV, III
(D) III, I, II, IV

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37. A non-native species that is introduced to a new area and causes ecological or economic harm is termed a(n):
(A) Keystone species
(B) Endemic species
(C) Invasive species
(D) Indicator species

38. Which of the following is NOT a primary type of biodiversity?
(A) Genetic diversity
(B) Geological diversity
(C) Species diversity
(D) Ecosystem diversity

39. The concept of 'Hotspots' of biodiversity was developed to identify areas that meet which two strict criteria?
(A) Large geographical area and presence of charismatic megafauna.
(B) High annual rainfall and low human population density.
(C) Presence of national parks and a high tourism rate.
(D) High number of endemic species and a high degree of threat.

CHAPTER 03

Environmental Biology

1. Which of the following best defines ecology as an interdisciplinary science?
(A) The scientific study of animal behavior within specific natural habitats.
(B) The study of interactions between organisms and their environment.
(C) The systematic classification and formal naming of living organisms.
(D) The study of chemical processes within and relating to living systems.

2. The concept of speciation is related to which of the following?
(A) The origin of life and the formation of new species.
(B) The process of systematic ecosystem classification.
(C) The historical development of human settlements.
(D) The complex flow of energy in a stable food web.

3. Which of the following statements about 'Human Ecology' is most accurate?
(A) It exclusively studies the impact of pollution on human health.
(B) It is a branch of sociology focused only on urban development.
(C) It examines relationships between human populations and environments.
(D) It is primarily concerned with the genetic evolution of humans.

4. Identify the correct statement regarding the structure of an ecosystem.
(A) Biotic components include non-living factors like temperature and light.
(B) Abiotic components consist of producers, consumers, and decomposers.
(C) Ecosystem structure is determined solely by dominant plant species.
(D) It is defined by the interaction of biotic and abiotic components.

5. What is the primary function of decomposers in an ecosystem's energy flow?
(A) To convert solar energy into chemical energy via photosynthesis.
(B) To consume various primary producers for their metabolic energy.
(C) To break down dead matter and return nutrients to the system.
(D) To form the first trophic level in all established food chains.

6. Which of the following represents a correct sequence in a detritus food chain?
(A) Grass → Grasshopper → Frog
(B) Dead leaves → Bacteria → Protozoa
(C) Phytoplankton → Zooplankton → Fish
(D) Sun → Algae → Small fish

7. Consider the following statements about energy flow in ecosystems:
I. Energy flows in a unidirectional manner, from producers to consumers.
II. There is a continuous gain of energy at each successive trophic level.
III. Energy flow models illustrate the quantitative relationships of energy transfer.
IV. The ultimate source of energy for most ecosystems is geothermal heat.
Which of the above statements are correct?
(A) I and II only
(B) I and III only
(C) II and IV only
(D) I, III and IV only

8. The cycling of elements like carbon, nitrogen, and phosphorus through the living and non-living components of an ecosystem is best described as:
(A) A biogeochemical cycle
(B) Energy flow
(C) Ecological succession
(D) A food web

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51. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Chronic toxicity results from prolonged or repeated exposure to a toxicant over a long period.
Reason (R) : The effects of chronic toxicity are always immediately apparent after the first exposure.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

52. What is the primary purpose of a bioassay in toxicology?
(A) To determine the chemical structure of a toxic substance.
(B) To excrete toxic agents effectively from the human body.
(C) To model the general flow of toxins in a large ecosystem.
(D) To measure activity via its effect on living organisms.

53. The concentration of an airborne chemical to which workers can be exposed day after day for a working lifetime without adverse effect is known as the:
(A) Margin of Safety
(B) Therapeutic Index
(C) Threshold Limit Value (TLV)
(D) Lethal Dose (LD50)

54. Biotransformation of a toxic agent in the body primarily refers to:
(A) The movement of the agent to various parts of the body.
(B) Metabolic conversion, often to water-soluble forms.
(C) The final elimination of the agent from the body.
(D) The accumulation of the agent in fatty tissues.

55. Which of the following is a major water-borne disease?
(A) Influenza
(B) Tuberculosis
(C) Measles
(D) Cholera

56. The use of living organisms, particularly microbes and plants, to clean up contaminated environments is called:
(A) Bioremediation
(B) Bio-prospecting
(C) Bioassay
(D) Biotransformation

57. Consider the following statements about bioremediation:
I. In situ bioremediation involves treating contaminated material at the site.
II. Ex situ bioremediation involves removing the contaminated material to be treated elsewhere.
III. Phytoremediation is a type of bioremediation that uses plants.
IV. Bioremediation is only effective for oil spills and not for heavy metal contamination.
Which of the above statements are correct?
(A) I and II only
(B) I, II, and III only
(C) III and IV only
(D) I, II, III, and IV

58. An organism whose presence, absence, or abundance reflects a specific environmental condition is known as a(n):
(A) Bioindicator
(B) Biofertilizer
(C) Biofuel
(D) Biosensor

59. Which of the following is an example of a biofertilizer?
(A) A genetically modified crop resistant to pests.
(B) Ethanol derived from corn for fuel use.
(C) A device that detects biological molecules.
(D) Rhizobium bacteria that fix atmospheric nitrogen.

60. A device that uses a biological component to detect a chemical substance is called a:
(A) Bioindicator
(B) Biosensor
(C) Biofuel
(D) Biofertilizer

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Which biome do these features describe?
(A) Tundra
(B) Taiga
(C) Temperate Grassland
(D) Deciduous Forest

101. Which of the following is an example of a biological invasion?
(A) A population of deer migrating seasonally between two valleys.
(B) The reintroduction of wolves into an area where they were previously extinct.
(C) The rapid growth of water hyacinth displacing native species.
(D) The process of primary succession on a newly formed volcanic island.

102. What type of community interaction is herbivory?
(A) + / +
(B) + / -
(C) + / 0
(D) - / -

103. The term 'threatened species' is a broad category that includes:
(A) Only extinct species.
(B) Only endangered species.
(C) Only species living in zoos.
(D) Endangered, vulnerable, and rare species.

104. Which of the following best describes the role of plants in ex situ bioremediation?
(A) They are grown on excavated soil to absorb pollutants.
(B) They are used as ground cover to prevent erosion.
(C) They are used as bioindicators to detect contaminants.
(D) They are not used in ex situ bioremediation processes.

105. A species that is found only in a specific geographical area and nowhere else is called:
(A) An invasive species
(B) A keystone species
(C) An endemic species
(D) A flagship species

106. Which of the following ecosystems is characterized by flowing water?
(A) Lentic
(B) Oceanic
(C) Wetland
(D) Lotic

107. A population's dispersion pattern being 'clumped' suggests that:
(A) Resources are patchy, or there is a social tendency to aggregate.
(B) Individuals are competing for a scarce and limited resource.
(C) Individuals are actively avoiding each other in the area.
(D) The environment is perfectly uniform with no social interactions.

108. Match List I with List II by selecting the correct pairing of ecological terms and definitions.
List I: (Term)
P. Bioremediation
Q. Bioindicator
R. Biofuel
S. Biosensor
List II: (Definition)
1. Fuel derived from biological material
2. An analytical device using a biological component
3. Use of organisms to clean up pollution
4. An organism indicating the quality of an environment
(A) P-3, Q-4, R-1, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

109. The concept of 'r' and 'k' selection refers to different:
(A) Methods of biodiversity conservation.
(B) Stages of ecological succession.
(C) Life history and reproductive strategies.
(D) Types of biogeochemical cycles.

110. The process of eliminating toxic substances from the body is known as:
(A) Absorption
(B) Distribution
(C) Biotransformation
(D) Excretion

111. Which of the following is NOT a characteristic of the Chapparal biome?

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71. In vitro conservation techniques primarily involve the preservation of:
(A) Entire ecosystems within their natural boundaries.
(B) Animal populations in their various natural habitats.
(C) Large tracts of forest land as official national parks.
(D) Genetic material preserved in artificial environments.

72. The term 'bio-prospecting' refers to:
(A) Scientific search for valuable genetic resources in nature.
(B) The illegal appropriation of genetic resources.
(C) The process of restoring a degraded ecosystem.
(D) The use of plants to remove pollutants from the soil.

73. The 'therapeutic index' of a drug is a measure of its:
(A) Speed of absorption.
(B) Effectiveness in treating a disease.
(C) Safety, comparing therapeutic dose to toxic dose.
(D) Rate of excretion from the body.

74. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : In situ conservation is generally considered the most ideal approach for preserving biodiversity.
Reason (R) : It conserves the entire ecosystem and allows evolutionary processes to continue in the natural environment.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

75. Which concept aims to study industrial manufacturing processes as interconnected systems, similar to ecological systems?
(A) Industrial Ecology
(B) Toxicology
(C) Restoration Ecology
(D) Human Ecology

76. The final and irreversible disappearance of a species from Earth is termed:
(A) Endangerment
(B) Extirpation
(C) Rarity
(D) Extinction

77. Which of the following is an example of a biofuel?
(A) Lichens growing on a rock, indicating air quality.
(B) Biodiesel produced from vegetable oils.
(C) Nitrogen-fixing bacteria in the soil.
(D) A glucose-detecting strip for diabetics.

78. The final stage of a natural succession, which is a relatively stable, self-perpetuating community, is called the:
(A) Climax community
(B) Pioneer community
(C) Seral community
(D) Ecotone community

79. Which of the following describes an incorrect pairing of a concept and its definition?
(A) Habitat - The physical place or environment where an organism lives.
(B) Niche - The functional role of an organism in its ecosystem.
(C) Ecotone - A sharp, impermeable barrier between two ecosystems.
(D) Species Diversity - The variety and abundance of different species.

80. What is the primary cause for the 'Highland Icy Alpine Biome' having sparse, low-growing vegetation?
(A) High rainfall and humidity in these regions.
(B) Overgrazing by large populations of herbivores.
(C) High levels of atmospheric pollution in mountains.
(D) Low temperatures and thin soil at high altitudes.

81. Consider the following statements:
I. A food web is a more realistic representation of feeding relationships in an ecosystem than a food chain.

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I. In situ conservation protects species in their natural habitat.
II. Ex situ conservation protects species outside their natural habitat.
III. National Parks are a method of ex situ conservation.
IV. Seed banks are a method of in situ conservation.

Which of the above statements are correct?
(A) I and II only
(B) I and III only
(C) II and IV only
(D) III and IV only

142. The process where plants are used to clean up contaminated soil or water is specifically called:
(A) Bio-augmentation
(B) Phytoremediation
(C) Bio-stimulation
(D) Mycoremediation

143. Which of the following is a characteristic of rangeland ecosystems?
(A) Dense, multi-layered forest canopy.
(B) Permanently frozen subsoil (permafrost).
(C) Dominated by grasses, forbs, and shrubs, often used for grazing.
(D) Water-saturated soils throughout the year.

144. In the context of population ecology, 'dispersion' refers to:
(A) The number of individuals per unit area.
(B) The age and sex structure of the population.
(C) The movement of individuals out of a population.
(D) The spatial pattern of individuals within a population.

145. A major cause of biodiversity loss where a large habitat is broken into smaller, isolated patches is known as:
(A) Over-exploitation
(B) Habitat fragmentation
(C) Biological invasion
(D) Co-extinction

146. Which of the following is NOT an example of a cultural ecosystem service?
(A) Nutrient cycling
(B) Spiritual and religious values
(C) Aesthetic enjoyment
(D) Ecotourism

147. A large-scale ecosystem classified primarily by its dominant vegetation and climate is a:
(A) Niche
(B) Population
(C) Biome
(D) Community

148. The final and irreversible disappearance of a species from Earth is termed:
(A) Endangerment
(B) Extirpation
(C) Rarity
(D) Extinction

149. The concept of 'Threshold Limit Value' (TLV) is most relevant in the field of:
(A) Population ecology.
(B) Occupational health and toxicology.
(C) Biodiversity conservation.
(D) Ecosystem classification.

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150. Consider the following threats to biodiversity:
I. Habitat loss and fragmentation
II. Introduction of invasive species
III. Over-exploitation of resources
IV. Pollution
V. Climate change

Which of these are recognized as major drivers of biodiversity loss?
(A) I and II only
(B) I, II, and III only
(C) I, II, III, and IV only
(D) I, II, III, IV, and V

151. Which of these Indian regions is a globally recognized biodiversity hotspot?
(A) The Thar Desert
(B) The Gangetic Plains
(C) The Western Ghats
(D) The Rann of Kutch

152. The interaction between a bee and a flower, where the bee gets nectar and the flower gets pollinated, is an example of:
(A) Parasitism
(B) Commensalism
(C) Competition
(D) Mutualism

91. Match List I with List II by selecting the correct pairing of conservation methods and examples.
List I: (Conservation Method)
P. In situ
Q. Ex situ
R. In vitro
S. Community-led in situ
List II: (Example)
1. Cryopreservation of gametes
2. Biosphere Reserve
3. Zoological Park
4. Sacred Grove
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-3, R-1, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-4, S-3

92. The study of the origin of life and the process of speciation falls under the broader field of:
(A) Toxicology
(B) Evolutionary Biology
(C) Industrial Ecology
(D) Community Ecology

93. An ecosystem's ability to recover quickly after a disturbance is known as:
(A) Resistance
(B) Stability
(C) Resilience
(D) Constancy

94. What is the key difference between a National Park and a Sanctuary in India?
(A) National Parks are for flora, while Sanctuaries are for fauna.
(B) No human activity is allowed in a Sanctuary, while activity is allowed in a Park.
(C) Sanctuaries are managed locally, while Parks are managed by the center.
(D) Parks have higher protection where most human activities are prohibited.

95. Read the following statements and select the correct option.
Statement I : The concept of a gene pool refers to all the genes of all the individuals in a population.
Statement II : Biopiracy involves the equitable and sustainable exploration of genetic resources for commercial development.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

96. A population exhibiting a J-shaped growth curve is undergoing:
(A) Logistic growth
(B) Exponential growth
(C) A population crash
(D) A stable equilibrium at carrying capacity

97. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Biological invasions by non-native species are a major threat to global biodiversity.
Reason (R) : Invasive species often outcompete native species for resources, introduce diseases, or alter the habitat, leading to a decline in native populations.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

98. Which of the following is considered a regulating ecosystem service?
(A) Climate regulation
(B) Fresh water
(C) Genetic resources
(D) Aesthetic beauty

99. Acute toxicity is characterized by:
(A) Adverse effects that occur after a long period of repeated exposure.
(B) The process of metabolizing a toxin within the hepatic system.
(C) Adverse effects occurring shortly after single or multiple doses.
(D) The accumulation of a toxin over time in the food chain.

100. Consider the following features:
I. Coniferous forests
II. Long, cold winters and short, cool summers
III. Located south of the Tundra
IV. Also known as Boreal Forest
V. Acidic, mineral-poor soil

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II. A food web consists of multiple interconnected food chains.
III. In a food web, an organism can occupy multiple trophic levels.
IV. Food webs demonstrate that energy flow is cyclical.

Which of the above statements are correct?
(A) I and II only
(B) I, II, and III only
(C) III and IV only
(D) I, II, III, and IV

82. The 'margin of safety' in toxicology is a concept used to:
(A) Establish safe human exposure from animal study data.
(B) Determine the exact dose that causes toxicity.
(C) Calculate the rate at which a toxin is eliminated.
(D) Classify toxins based on their chemical structure.

83. Which of these is an example of ex situ remediation?
(A) Adding nutrients to soil to stimulate microbial activity at a contaminated site.
(B) Using plants to extract heavy metals from the ground in their original location.
(C) Excavating contaminated soil and treating it in a bioreactor.
(D) Pumping air into the groundwater to enhance degradation of pollutants.

84. A community is defined in ecology as:
(A) A group of individuals of the same species living in an area.
(B) The physical environment in which various organisms live.
(C) A large-scale biome with a specific and distinct climate.
(D) All interacting populations of species in a given area.

85. Which of the following is an example of a provisioning ecosystem service?
(A) Pollination
(B) Carbon sequestration
(C) Timber
(D) Spiritual enrichment

86. Arrange the following biomes chronologically based on their location from the highest latitude to the lowest latitude:
I. Tropical Rain Forest
II. Tundra
III. Deciduous Forest
IV. Taiga

Which of the following is the correct sequence?
(A) I, III, IV, II
(B) II, III, IV, I
(C) II, IV, III, I
(D) IV, II, III, I

87. The concept of a 'metapopulation' is most useful for understanding the dynamics of:
(A) Species living in large, continuous habitats.
(B) Species with a very stable and unchanging population size.
(C) A single, isolated population with no immigration.
(D) Species in fragmented habitats with migration.

88. Identify the incorrect statement about biodiversity hotspots.
(A) They have low species richness but high abundance.
(B) They are areas with a high percentage of endemic species.
(C) They are areas that have lost a significant portion of their original habitat.
(D) India has several designated biodiversity hotspots.

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89. A researcher finds that a certain fungus releases a compound that prevents the seeds of a nearby plant from germinating. This is a clear example of:
(A) Parasitism
(B) Mutualism
(C) Allelopathy
(D) Herbivory

90. Which measure of biodiversity considers the number of species in an area and their relative abundance?
(A) Species diversity indices (e.g., Shannon-Wiener)
(B) Species richness
(C) Species evenness
(D) Endemism

(A) Dominated by broad-leaf evergreen shrubs.
(B) Presence of permafrost.
(C) Climate with hot, dry summers and mild, rainy winters.
(D) Frequent fires are a natural part of the ecosystem.

112. The Indian Parliament passed the Biological Diversity Act, which is crucial for regulating access to biological resources and preventing biopiracy, in which year?
(A) 200_2
(B) 197_2
(C) 1986
(D) 2010

113. If a toxicant is excreted very slowly, it is likely to:
(A) Undergo rapid biotransformation.
(B) Bioaccumulate in the body.
(C) Have a very low acute toxicity.
(D) Have a very high therapeutic index.

114. Consider the following statements about Human Ecology and Settlement:
I. Human settlements can significantly alter local ecosystems.
II. Human ecology studies the one-way impact of the environment on humans, not the other way around.
III. Urbanization is a key topic within the study of human settlements and their ecological impact.
IV. The design of sustainable human settlements is a goal related to human ecology.
Which of the above statements are correct?
(A) I and II only
(B) I, III, and IV only
(C) II and IV only
(D) I, II, III, and IV

115. A microorganism that requires oxygen for growth and is found in the air is best described as an:
(A) Obligate anaerobe
(B) Facultative anaerobe
(C) Water-borne microbe
(D) Airborne aerobe

116. The concept of ecological succession helps to explain:
(A) How energy flows from one trophic level to the next.
(B) How communities change over time after a disturbance.
(C) How species interact through predation and competition.
(D) How populations are spatially distributed.

117. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Ecosystems with complex food webs are generally more stable than those with simple food chains.
Reason (R) : In a complex food web, the loss of one species can be compensated for by other species, providing alternative energy pathways.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

118. The main objective of 'Restoration Ecology' is to:
(A) Assist the recovery of an ecosystem that has been degraded, damaged, or destroyed.
(B) Introduce new, exotic species to increase biodiversity.
(C) Convert natural habitats into agricultural land.
(D) Create a detailed inventory of all species in a pristine ecosystem.

119. Which of the following is a key characteristic of 'k'-strategist species?
(A) Large number of offspring
(B) Little or no parental care
(C) Slow development and long lifespan
(D) High population growth rate

120. In toxicology, LD50 refers to:
(A) The lowest dose that causes a detectable effect.
(B) The dose that is lethal to 50% of a test population.
(C) The safe limit for daily exposure.
(D) The dose that is 50% effective in treating a disease.

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121. The origin of life is a fundamental concept in environmental biology that science hypothesizes began with:
(A) The formation of complex and diverse ecosystems.
(B) Self-replicating molecules in abiotic environments.
(C) The first appearance of complex vertebrate animals.
(D) The historical process of systematic human settlement.

122. Which of the following is NOT commonly categorized as a major natural ecosystem type?
(A) Urban
(B) Desert
(C) Forest
(D) Oceanic

123. The '10% rule' of energy transfer in ecosystems suggests that:
(A) Only 10% of the energy from the sun is captured by producers.
(B) 10% of all species are keystone species.
(C) Each trophic level passes on approximately 10% of its energy to the next level.
(D) An ecosystem can only support 10 trophic levels.

124. Consider the following:
I. National Park
II. Botanical Garden
III. Gene Bank
IV. Sanctuary
V. Sacred Grove
Which of the above are examples of in situ conservation?
(A) I and IV only
(B) I, IV, and V only
(C) II and III only
(D) I, II, III, and IV only

125. The ecological interaction in which both interacting species are harmed is:
(A) Predation
(B) Parasitism
(C) Competition
(D) Amensalism

126. What is the primary role of a biofertilizer?
(A) To increase the nutritional value of crops through genetic modification.
(B) To enhance the nutrient availability to plants through the activity of microorganisms.
(C) To produce fuel from agricultural waste.
(D) To kill pests that attack crops.

127. Which of the following biomes would have the highest net primary productivity per unit area?
(A) Tundra
(B) Desert
(C) Taiga
(D) Tropical Rain Forest

128. The identification of 'Hotspots' is a strategy focused on conserving:
(A) Areas with high species richness and high levels of threat.
(B) Areas with the largest number of individuals of a single species.
(C) Only aquatic ecosystems.
(D) Areas that are most suitable for human settlement.

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129. The random pattern of population dispersion occurs when:
(A) Resources are patchy, and individuals are attracted to them.
(B) The environment is uniform, and there are no strong social interactions.
(C) Individuals are highly territorial.
(D) The population has exceeded its carrying capacity.

130. Which of the following is a characteristic of a pioneer species in primary succession?
(A) Ability to grow on bare rock or mineral soil.
(B) Large size and slow growth.
(C) High nutrient requirements.
(D) Shade-tolerant.

131. Match List I with List II by selecting the correct pairing of toxicology terms and descriptions.
List I: (Toxicology Term)
P. Absorption
Q. Distribution
R. Biotransformation
S. Excretion
List II: (Description)
1. Movement of a substance through the body via the bloodstream
2. Chemical alteration of a substance within

the body
3. Elimination of a substance from the body
4. Entry of a substance into the body

(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-3, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-3, Q-1, R-2, S-4

132. A species that is not native to a particular region and has been introduced either intentionally or accidentally is known as:
(A) An endemic species
(B) An exotic or alien species
(C) A keystone species
(D) A pioneer species

133. The concept that industrial systems should be designed to mimic the material and energy flows of natural ecosystems is central to:
(A) Environmental Biotechnology
(B) Community Ecology
(C) Industrial Ecology
(D) Toxicology

134. Which of these conservation strategies falls under the category of 'in vitro'?
(A) Establishing a Biosphere Reserve.
(B) Maintaining a collection of animals in a zoo.
(C) Protecting a traditional sacred grove.
(D) Cryopreservation of seeds and embryos.

135. Arrange the following typical stages of hydrarch succession (succession in water) in chronological order:
I. Submerged stage
II. Reed-swamp stage
III. Phytoplankton stage
IV. Climax forest
Which of the following is the correct sequence?
(A) III, II, I, IV
(B) I, III, II, IV
(C) III, I, II, IV
(D) I, II, III, IV

136. An example of a supporting ecosystem service is:
(A) Production of fish.
(B) Soil formation.
(C) Regulation of floods.
(D) Recreational opportunities.

137. Which of the following is an example of a population fluctuation?
(A) The unidirectional flow of energy through an ecosystem.
(B) The gradual replacement of one plant community by another.
(C) The seasonal increase and decrease in the number of insects.
(D) The stable population of a 'k'-selected species at carrying capacity.

138. Read the following statements and select the correct option.
Statement I : The 'therapeutic index' is calculated as the ratio of the toxic dose to the therapeutic dose.
Statement II : A large therapeutic index indicates that a drug is relatively safe.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

139. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Mangrove ecosystems are classified as estuarine.
Reason (R) : They thrive in the brackish water environment where freshwater from rivers mixes with saltwater from the sea.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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140. A species designated as 'Extinct in the Wild' (EW) means that:
(A) The species has completely vanished from the Earth.
(B) The species is facing a very high risk of extinction.
(C) The species is abundant in its natural habitat.
(D) The species survives only in cultivation or captivity.

141. Consider the following statements about biodiversity conservation:

61. Which of the following is an abiotic component of a forest ecosystem?
(A) Decomposing fungi
(B) An oak tree
(C) The amount of annual rainfall
(D) A deer

62. In a typical energy pyramid, which trophic level has the largest biomass?
(A) Primary consumers
(B) Secondary consumers
(C) Tertiary consumers
(D) Producers

63. Match List I with List II by selecting the correct pairing of biomes and key features.
List I: (Biome)
P. Grassland
Q. Chapparal
R. Highland Icy Alpine
S. Savanna
List II: (Key Feature)
1. High altitude, low temperature, treeless
2. Dominated by grasses, few trees, moderate rainfall
3. Scattered trees in a grassy landscape, distinct wet/dry seasons
4. Sclerophyllous shrubs, hot-dry summers, mild-rainy winters
(A) P-1, Q-3, R-2, S-4
(B) P-2, Q-4, R-1, S-3
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

64. The change in species composition at the boundary of two habitats is known as the:
(A) Ecotone effect
(B) Edge effect
(C) Niche effect
(D) Succession effect

65. The ability of an ecosystem to resist disturbance and maintain its structure and function is called:
(A) Resilience
(B) Resistance (Stability)
(C) Succession
(D) Fluctuation

66. A cold desert, such as the one in Ladakh, is characterized by:
(A) Extreme cold winters, hot summers, and sparse vegetation.
(B) Heavy snowfall throughout the year and dense forests.
(C) Permafrost and a complete absence of plant life.
(D) High humidity and abundant rainfall in summer months.

67. Which of the following correctly pairs an ecosystem type with its defining characteristic?
(A) Lotic - Standing water environments like ponds.
(B) Rangeland - Land areas dominated by dense forest.
(C) Wetland - Saturated soil and hydrophytic vegetation.
(D) Forest - Permafrost soil layer with mosses.

68. Population regulation factors that are dependent on population density, such as competition and predation, are known as:
(A) Density-independent factors
(B) Abiotic factors
(C) Fluctuation factors
(D) Density-dependent factors

69. Consider the following statements about community interactions:
I. Predation is an interaction where one species hunts and kills another.
II. Herbivory is a form of predation where the prey is a plant.
III. Allelopathy is a competitive interaction mediated by chemicals.
IV. Parasitism always results in the immediate death of the host.
V. Biological invasion involves native species expanding their range.
Which of the above statements are correct?
(A) I, II, and III only
(B) I, III, and V only
(C) II, IV, and V only
(D) I, II, III, and IV only

70. Which of the following is NOT a major threat to biodiversity?
(A) Habitat destruction
(B) Speciation
(C) Over-exploitation
(D) Pollution

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153. A graphical representation of the feeding relationships among species in an ecosystem, showing the flow of energy, is called a:
(A) Biogeochemical cycle
(B) Food web
(C) Population growth curve
(D) Succession diagram

154. Match List I with List II by selecting the correct pairing of species categories and descriptions.
List I: (Species Category)
P. Endangered
Q. Extinct
R. Keystone
S. Invasive
List II: (Description)
1. No known living individuals exist
2. Has a disproportionately large effect on its ecosystem
3. A non-native species causing harm
4. Faces a very high risk of extinction in the wild
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-1, R-2, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-1, R-3, S-2

155. The conversion of a toxic substance into a less harmful one by metabolic processes in the body is a part of:
(A) Bioassay
(B) Absorption
(C) Excretion
(D) Biotransformation

156. In an ecosystem, which of the following is NOT recycled?
(A) Energy
(B) Carbon
(C) Nitrogen
(D) Water

157. The 'Highland Icy Alpine Biome' is the mountain equivalent of which other biome?
(A) Taiga
(B) Desert
(C) Tundra
(D) Grassland

158. Which statement about 'r-strategists' is incorrect?
(A) They are typically small in size.
(B) They have a long life span.
(C) They produce many offspring.
(D) They provide little to no parental care.

159. A bio-indicator for water pollution could be:
(A) The presence of a wide variety of fish species.
(B) The presence of clear, fast-flowing water.
(C) A high concentration of dissolved oxygen.
(D) The absence of species like stoneflies and mayflies.

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160. The primary goal of a seed bank is:
(A) To serve as a repository for plant genetic material for long-term conservation.
(B) To provide seeds to farmers for annual cultivation.
(C) To study the process of seed germination under different conditions.
(D) To create genetically modified seeds.

161. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The concept of carrying capacity (K) applies to populations experiencing exponential growth.
Reason (R) : Exponential growth occurs in an environment with unlimited resources, where there is no upper limit to population size.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

162. The variety of life at all levels of biological organization is termed:
(A) Biodiversity
(B) Ecology
(C) Biome
(D) Biosphere

163. The use of microbes for in situ bioremediation is an example of:
(A) Removing contaminated soil for treatment.
(B) Using plants to absorb pollutants.
(C) Treating contamination at its original location.

(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-3, S-4

246. The scientific study of human populations, their characteristics, and their relationship with the environment is known as:
(A) Speciation
(B) Human Ecology
(C) Industrial Ecology
(D) Toxicology

247. Which biome is characterized by having the greatest diversity of species?
(A) Tundra
(B) Desert
(C) Taiga
(D) Tropical Rain Forest

248. The absorption, distribution, metabolism (biotransformation), and excretion of toxicants are collectively known as:
(A) Toxicokinetics
(B) Toxicodynamics
(C) Bioassay
(D) Bioremediation

249. Which of the following conservation strategies provides the broadest level of protection by conserving entire ecosystems and landscapes?
(A) Seed banks
(B) Zoological parks
(C) Biosphere Reserves
(D) Botanical gardens

250. An organism's 'ecological niche' is best described as its:
(A) Physical address or location.
(B) Trophic level in the food chain.
(C) Position in the evolutionary tree.
(D) Functional role or profession in the ecosystem.

Direction : Please read the following source carefully.

The structure of an ecosystem is defined by its biotic and abiotic components, which interact to create a functional whole. Biotic components encompass all living organisms, categorized into producers, consumers, and decomposers, while abiotic components include non-living factors like sunlight, temperature, water, and soil chemistry. The primary function of an ecosystem revolves around the flow of energy and the cycling of nutrients. Energy flow is a unidirectional process, typically beginning with solar energy captured by producers through photosynthesis. This energy is then transferred through various trophic levels via food chains and more complex, interconnected food webs. Energy flow models are used to illustrate this transfer, highlighting the progressive loss of energy at each successive level. Concurrently, biogeochemical cycles facilitate the movement and transformation of essential elements like carbon, nitrogen, and phosphorus between the biotic and abiotic realms. Another critical functional aspect is ecological succession, the process of gradual and predictable change in species composition in a given area. This can be primary, occurring on lifeless substrates, or secondary, following a disturbance in an existing community. These integrated processes of energy transfer, nutrient cycling, and community development underscore the dynamic nature of ecosystem functions.

Based on the above source, attempt the following five questions.

251. Which of the following accurately describes the fundamental difference between energy flow and biogeochemical cycling in an ecosystem?
(A) Energy flow is cyclical, whereas biogeochemical cycling is unidirectional.
(B) Energy flow is a unidirectional process, whereas biogeochemical cycling involves the movement of elements between biotic and abiotic components.
(C) Both energy flow and biogeochemical cycling are unidirectional and involve progressive loss.
(D) Biogeochemical cycling pertains only to abiotic components, while energy flow pertains only to biotic components.

252. According to the paragraph, ecological succession is best defined as:
(A) The gradual and predictable change in species composition over time.
(B) The stable, unchanging state of species in a given area.
(C) The daily interaction between biotic and

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175. Consider the following:
I. Presence of halophytic (salt-tolerant) vegetation
II. Acts as a coastal buffer zone
III. High primary productivity
IV. Found in tropical and subtropical intertidal zones
V. Brackish water conditions
Which ecosystem are these features characteristic of?
(A) Rangeland
(B) Cold Desert
(C) Mangrove (Estuarine)
(D) Lotic

176. The concept of a species' niche includes all of the following EXCEPT:
(A) Its role in the flow of energy.
(B) The number of individuals in its population.
(C) The temperature and humidity it tolerates.
(D) Its interactions with other species.

177. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The process of speciation increases biodiversity.
Reason (R) : Speciation is the evolutionary process that results in the formation of new and distinct species.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

178. The study of major water-borne diseases and air-borne microbes is a key component of which field of study?
(A) Toxicology and Microbiology
(B) Population Ecology
(C) Biodiversity and its Conservation
(D) Ecosystem Structure and Functions

179. A protected area where collection of minor forest products, grazing, and other human activities are allowed without adversely affecting the wildlife is a:
(A) National Park
(B) Core zone of a Biosphere Reserve
(C) Wildlife Sanctuary
(D) Sacred Grove

180. The logistic growth model (S-shaped curve) differs from the exponential model (J-shaped curve) because it includes:
(A) The concept of a pioneer community.
(B) The intrinsic rate of natural increase (r).
(C) The process of speciation.
(D) The effect of environmental resistance and K.

181. Match List I with List II by selecting the correct symbolic representation of ecological interactions.
List I: (Interaction)
P. Mutualism
Q. Predation
R. Commensalism
S. Competition
List II: (Symbolic Representation)
1. + / -
2. - / -
3. + / +
4. + / 0
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-4, S-3

182. A species designated as 'Rare' is characterized by:
(A) A small population, which is not currently 'Endangered' or 'Vulnerable', but is at risk.
(B) A large global population that is under threat.
(C) Being extinct in its natural habitat.
(D) Being a non-native species with a small population.

183. Which of the following best describes 'Ecology as an inter-disciplinary science'?
(A) It is a sub-field of biology only.
(B) It focuses solely on interactions between animals.
(C) It integrates principles from multiple scientific fields.
(D) It is primarily concerned with the classification of plants.

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V. Biological invasions

Which of the above are considered threats to biodiversity?

(A) I, II, and III only
(B) I, III, IV, and V only
(C) II, III, and IV only
(D) I, II, III, IV and V

226. The functional unit of ecology is the:
(A) Population
(B) Ecosystem
(C) Community
(D) Biome

227. In the context of speciation, allopatric speciation occurs when:
(A) A new species arises within the same area as the parent species.
(B) A species becomes extinct due to various environmental changes.
(C) Two populations are separated by a geographical barrier.
(D) A population's gene pool remains constant over a period of time.

228. Read the following statements and select the correct option.

Statement I : Bio-prospecting is the illegal patenting of bio-resources without proper authorization.

Statement II : Biopiracy is the exploration of molecular, genetic and species-level diversity for products of economic value.

(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

229. A key feature of a rangeland ecosystem is that it is primarily:
(A) A source of timber and wood products.
(B) A land area for grazing livestock and wildlife.
(C) A habitat for aquatic life.
(D) A region with permanent snow cover.

230. The movement and exchange of organic and inorganic matter back into the production of living matter is the essence of a:
(A) Food web
(B) Trophic level
(C) Energy flow model
(D) Biogeochemical cycle

231. Which of the following correctly describes a 'keystone species'?
(A) A species that is the most abundant in the community.
(B) A species that has recently invaded a new habitat.
(C) A species with high impact relative to its abundance.
(D) A species that is hunted by many predators.

232. An example of a 'biofuel' is:
(A) Coal
(B) Ethanol
(C) Natural Gas
(D) Petroleum

233. The 'Highland Icy Alpine Biome' is characterized by conditions similar to:
(A) The Desert biome, but with ice instead of sand.
(B) The Tropical Rain Forest, but with colder temperatures.
(C) The Tundra biome, but found at high altitudes.
(D) The Taiga biome, but without any trees.

234. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : The use of biofertilizers is promoted as a sustainable agricultural practice.

Reason (R) : Biofertilizers can improve soil fertility by fixing atmospheric nitrogen or solubilizing phosphorus, reducing the need for chemical fertilizers.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

235. The practice of conserving components of biological diversity outside their natural habitats is known as:
(A) In situ conservation
(B) In vivo conservation
(C) In vitro conservation

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194. Which of the following is a measure for ex situ biodiversity conservation?
(A) Cryopreservation
(B) Biosphere Reserve
(C) National Park
(D) Sacred Grove

195. What is the main characteristic of the grassland biome?
(A) Dominated by coniferous trees.
(B) Extremely cold temperatures and permafrost.
(C) Land dominated by grasses rather than shrubs or trees.
(D) Very high annual rainfall and dense vegetation.

196. The process of increasing concentration of a toxic substance in the tissues of organisms at successively higher levels in a food chain is:
(A) Bioaccumulation
(B) Biotransformation
(C) Biodegradation
(D) Biomagnification

197. Which of the following is an example of a water-borne disease caused by bacteria?
(A) Typhoid
(B) Measles
(C) Smallpox
(D) Influenza

198. The 'edge effect' in ecology refers to:
(A) The extinction of species at the edge of their range.
(B) Structural changes at the boundary of two habitats.
(C) The sharp decline in resources at the edge of an ecosystem.
(D) The effect of a keystone species on the ecosystem's edge.

199. The flora and fauna of India that are at risk of extinction are classified as:
(A) Bioprospected and Biopirated.
(B) In situ and Ex situ.
(C) Extinct, Rare, Endangered and Threatened.
(D) 'r' and 'k' selected.

200. Consider the following statements:
I. Azotobacter is a free-living nitrogen-fixing bacterium used as a biofertilizer.
II. Ethanol from sugarcane is a type of biofuel.
III. Lichens are good bioindicators of air pollution, especially SO2.
IV. A biosensor converts a biological response into an electrical signal.
V. A biofertilizer's primary role is to act as a pesticide.
Which of the above statements are correct?
(A) I and V only
(B) II, III and IV only
(C) I, II, III and IV only
(D) I, II, III, IV, and V

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201. The Tundra biome is treeless because of:
(A) High soil salinity.
(B) Frequent forest fires.
(C) Extremely low temperatures and permafrost.
(D) Low rainfall.

202. The concept of a 'gene pool' is most directly related to which level of biodiversity?
(A) Ecosystem diversity
(B) Genetic diversity
(C) Species diversity
(D) Community diversity

203. Which of the following is an incorrect statement regarding ecosystem functions?
(A) Energy flows unidirectionally through an ecosystem.
(B) Nutrients are cycled continuously within an ecosystem.
(C) Decomposers play a vital role in nutrient recycling.
(D) Energy is created by producers and destroyed by top consumers.

204. Match List I with List II by selecting the correct pairing of biomes and dominant vegetation or climate.
List I: (Biome)
P. Tropical Rain Forest
Q. Desert (Hot)
R. Tundra
S. Taiga
List II: (Dominant Vegetation/Climate)
1. Coniferous trees
2. Mosses, lichens, dwarf shrubs
3. Broadleaf evergreen trees
4. Cacti and succulents

184. The gradual buildup of a toxic chemical in the tissues of an individual organism over its lifetime is:
(A) Biotransformation
(B) Bioaccumulation
(C) Biomagnification
(D) Bioassay

185. A case study of the reintroduction of wolves to Yellowstone National Park, which led to a cascade of changes in the ecosystem, demonstrates the concept of a:
(A) Pioneer species
(B) Keystone species
(C) Invasive species
(D) 'r'-selected species

186. Which of the following is a cultural service provided by an ecosystem?
(A) Aesthetic value
(B) Food
(C) Water purification
(D) Soil formation

187. Read the following statements regarding biomes and select the correct option.
Statement I : A biome is a large community of plants and animals that occupies a distinct region.
Statement II : The distribution of biomes is primarily determined by latitude, altitude, and climate.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

188. 'Human Ecology and Settlement' studies the dynamic relationship between:
(A) Different species of hominids.
(B) Humans and their physical/biotic environments.
(C) The structure of rural and urban settlements only.
(D) The geological history of human habitation sites.

189. All of the following are examples of density-dependent population regulation factors EXCEPT:
(A) Competition for food
(B) A sudden volcanic eruption
(C) Spread of a contagious disease
(D) Predation

190. Consider the following statements regarding ecosystem stability:
I. High biodiversity generally increases ecosystem stability.
II. Simple food chains are more stable than complex food webs.
III. Ecosystem resistance is the ability to withstand disturbance.
IV. Ecosystem resilience is the ability to recover after disturbance.
Which of the above statements are correct?
(A) I, II and III only
(B) II and IV only
(C) I, III and IV only
(D) I, II, III and IV

191. The primary difference between a lotic and a lentic ecosystem lies in:
(A) The salinity of the water.
(B) The depth of the water.
(C) The movement of the water (flowing vs. standing).
(D) The biological productivity of the water.

192. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Industrial ecology promotes a linear 'cradle-to-grave' flow of materials.
Reason (R) : The goal is to maximize resource use and waste generation to drive economic growth.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) Both A and R are false.

193. The concept of 'biopiracy' is a significant issue related to:
(A) The restoration of degraded ecosystems.
(B) The fair and equitable sharing of benefit from genetic resources.
(C) The process of ecological succession.
(D) The flow of energy in a food web.

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contaminated material for treatment.
IV. It is only applicable to organic pollutants and not to heavy metals.
Which of the above statements are correct?
(A) I and II only
(B) I, II and III only
(C) II and IV only
(D) All are correct

216. The concept of carrying capacity is directly associated with:
(A) The process of speciation.
(B) The logistic model of population growth.
(C) The definition of a biome.
(D) The flow of energy in a food chain.

217. In which biome would you most likely find permafrost?
(A) Tropical Rain Forest
(B) Tundra
(C) Desert
(D) Deciduous Forest

218. The ecological principle that no two species can occupy the same ecological niche in the same habitat at the same time is known as:
(A) The competitive exclusion principle
(B) The 10% law
(C) The concept of keystone species
(D) The theory of island biogeography

219. Which of the following represents an example of in situ bioremediation?
(A) Excavating contaminated soil and burning it in an incinerator.
(B) Transporting contaminated water to a treatment facility.
(C) Pumping nutrients into the ground to stimulate naturally occurring microbes.
(D) Growing plants in a lab on a sample of contaminated soil.

220. Match List I with List II by selecting the correct pairing of conservation areas and primary purposes.
List I: (Conservation Area)
P. National Park
Q. Sanctuary
R. Biosphere Reserve
S. Sacred Grove
List II: (Primary Purpose)
1. Conservation of overall biodiversity and sustainable use, with zones
2. Traditional community-based conservation of a patch of forest
3. High degree of protection for wildlife and habitat
4. Protection of specific fauna; some human activities may be allowed
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-3, R-2, S-1
(D) P-3, Q-1, R-4, S-2

221. The savanna biome is a transitional ecosystem between which two major biomes?
(A) Tundra and Taiga
(B) Deciduous Forest and Grassland
(C) Desert and Tundra
(D) Tropical Rain Forest and Desert

222. The term 'rare' fauna refers to species that are:
(A) Facing an immediate threat of extinction.
(B) Already extinct from the wild.
(C) Thinly scattered over a wider area or in specific limited areas.
(D) Non-native and have been recently introduced.

223. What does TLV (Threshold Limit Value) in toxicology represent?
(A) The maximum dose that is lethal to an organism.
(B) The safe level of worker exposure over a working lifetime.
(C) The minimum concentration detectable by a biosensor.
(D) The therapeutic level of a drug in the bloodstream.

224. Which of these is an example of an 'air borne microbe'?
(A) Influenza virus
(B) Vibrio cholerae
(C) Escherichia coli in water
(D) Salmonella typhi

225. Consider the following:
I. Habitat destruction
II. Genetic diversity
III. Overexploitation
IV. Pollutants

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(D) Creating a physical barrier to contain pollutants.

164. Consider the following features:
I. Broad-leaved trees that shed their leaves annually
II. Moderate rainfall
III. Distinct warm and cold seasons
IV. Fertile soils enriched by decaying leaves
Which biome are these characteristics of?
(A) Tropical Rain Forest
(B) Taiga
(C) Deciduous Forest Biome
(D) Savanna

165. The study of the absorption, distribution, and excretion of toxic agents in living organisms is the core of:
(A) Pharmacokinetics
(B) Ecotoxicology
(C) Toxicology (specifically, toxicokinetics)
(D) Environmental biotechnology

166. Which one of the following is NOT a level of biodiversity?
(A) Genetic diversity
(B) Niche diversity
(C) Species diversity
(D) Ecosystem diversity

167. Arrange the following conservation efforts in India in chronological order based on their enactment year:
I. The Wildlife (Protection) Act
II. The Biological Diversity Act
III. Project Tiger
IV. The Environment (Protection) Act
Which of the following is the correct sequence?
(A) I, III, IV, II
(B) I, II, III, IV
(C) III, I, II, IV
(D) IV, I, III, II

168. Which of the following is a potential consequence of biological invasion?
(A) Extinction of native species.
(B) Increased stability of the native ecosystem.
(C) An increase in genetic diversity of the ecosystem.
(D) A decrease in competition for resources.

169. What type of interaction occurs when an orchid grows on a tree, where the orchid benefits by getting better light exposure and the tree is unaffected?
(A) Parasitism (+/-)
(B) Mutualism (+/+)
(C) Commensalism (+/0)
(D) Competition (-/-)

170. Which of the following statements about biogeochemical cycles is true?
(A) They involve only the biotic components of an ecosystem.
(B) They represent a one-way flow of nutrients.
(C) They are unrelated to energy flow in ecosystems.
(D) They describe the movement of chemical elements through the Earth's spheres.

171. A scientist wants to create a device that glows in the presence of a specific pollutant. This device would be classified as a:
(A) Bioindicator
(B) Biofertilizer
(C) Biosensor
(D) Biofuel

172. The richness and variety of life found in India, including the Western Ghats and Himalayas, makes it a:
(A) Monoculture country
(B) Low-biodiversity country
(C) Biome-deficient country
(D) Mega-diversity country

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173. What is the fundamental difference between 'r' and 'k' species?
(A) Their trophic level in the food web.
(B) Their reproductive strategy and environmental response.
(C) Their specific geographical or climatic location.
(D) Their classification as either a plant or animal.

174. Which of the following pairs is incorrectly matched?
(A) In situ conservation - Seed bank
(B) Hotspot - High endemism
(C) Keystone species - Disproportionate impact
(D) Allelopathy - Chemical inhibition

(D) Ex situ conservation

236. The definition of a community in ecology includes:
(A) All populations of different species interacting in a given area.
(B) Only the plant species in a given area.
(C) The biotic and abiotic factors in a given area.
(D) A single species and its environment.

237. Which statement about the flow of energy in an ecosystem is correct?
(A) It is cyclical and reused by producers.
(B) It is transferred from one trophic level to the next with 100% efficiency.
(C) It is unidirectional and decreases at each successive trophic level.
(D) It originates from decomposers.

238. Consider the following statements about biodiversity hotspots:
I. The concept was introduced by Norman Myers.
II. A region must have a high number of endemic species.
III. A region must have lost a significant percentage of its original habitat.
IV. The Indo-Burma region is one such hotspot relevant to India.
V. They are primarily identified based on their economic value.
Which of the above statements are correct?
(A) I, II, and V only
(B) I, II, III, and IV only
(C) III, IV, and V only
(D) I, II, III, IV, and V

239. The process of speciation leads to:
(A) A decrease in genetic diversity.
(B) The stabilization of the gene pool.
(C) The mixing of two separate species into one.
(D) The formation of new species, thus increasing species diversity.

240. An estuarine ecosystem is a transitional zone between:
(A) A lake and a river.
(B) A river and the sea.
(C) A forest and a grassland.
(D) A mountain and a valley.

241. What is the key role of decomposers in the biogeochemical cycles?
(A) They are the primary source of energy for the cycle.
(B) They release essential nutrients from dead organic matter back into the ecosystem.
(C) They convert inorganic compounds into organic compounds using sunlight.
(D) They prevent the cycling of nutrients to conserve them.

242. Which of the following is NOT a type of community interaction?
(A) Photosynthesis
(B) Predation
(C) Parasitism
(D) Symbiosis

243. The concept of 'Restoration Ecology' deals with:
(A) Creating new ecosystems from scratch.
(B) Studying the ecology of pristine, untouched environments.
(C) Restoring degraded ecosystems to a more natural state.
(D) The commercial exploitation of ecological resources.

244. The main threat posed by 'biological invasions' is:
(A) The increase in the number of species in an ecosystem.
(B) The creation of new food sources for native predators.
(C) The strengthening of the native gene pool.
(D) The potential for invasive species to outcompete and displace native species.

245. Match List I with List II by selecting the correct pairing of organisms or substances with their roles in biotechnology or ecology.
List I: (Organism/Substance)
P. Rhizobium
Q. Lichen
R. Penicillium
S. Yeast
List II: (Role in Biotechnology/Ecology)
1. Bioindicator for air pollution
2. Production of biofuel (ethanol)
3. Source of antibiotic (a biotransformation product)
4. Biofertilizer (nitrogen fixation)

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(A) P-3, Q-4, R-2, S-1
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-3, R-1, S-4

205. The exploration of biodiversity for commercially valuable genetic and biochemical resources is known as:
(A) Biopiracy
(B) Restoration ecology
(C) Bio-prospecting
(D) In vitro conservation

206. In the context of toxicology, 'chronic toxicity' refers to adverse health effects from:
(A) A single, large dose of a toxic substance.
(B) Repeated exposure over a prolonged period.
(C) The therapeutic use of a pharmaceutical drug.
(D) A substance with a very high margin of safety.

207. Which of the following is the best example of a supporting ecosystem service?
(A) Food production
(B) Climate regulation
(C) Recreational hiking
(D) Pollination

208. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : 'r-selected' species are often the first to colonize a disturbed or newly created habitat.
Reason (R) : Their characteristics, such as rapid growth, high fecundity, and good dispersal ability, make them effective pioneers.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

209. A network of interconnected populations, with individuals moving between them, is called a:
(A) Community
(B) Metapopulation
(C) Biome
(D) Gene pool

210. What is a primary objective of establishing protected areas like national parks and sanctuaries?
(A) To facilitate in situ conservation of biodiversity.
(B) To promote industrial development.
(C) To provide land for urban expansion.
(D) To conduct experiments in ex situ conservation.

211. Arrange the following levels of biological organization from simplest to most complex:
I. Population
II. Ecosystem
III. Community
IV. Organism
Which of the following is the correct sequence?
(A) IV, I, III, II
(B) I, IV, III, II
(C) IV, I, II, III
(D) I, III, IV, II

212. A species whose conservation is expected to confer protection to a large number of other species in the same habitat is often called a(n):
(A) Invasive species
(B) Pioneer species
(C) 'r'-strategist species
(D) Umbrella species

213. 'Therapeutic Index' is a ratio used to determine the relative safety of which of the following?
(A) An industrial chemical
(B) An airborne microbe
(C) A pharmaceutical drug
(D) A food additive

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214. Which one of the following is NOT an abiotic component of an ecosystem?
(A) Sunlight
(B) Bacteria
(C) Temperature
(D) Water

215. Consider the following statements about bioremediation:
I. It is a process that uses living organisms to degrade environmental contaminants.
II. In situ bioremediation means the treatment is performed at the site of contamination.
III. Ex situ bioremediation involves moving the

abiotic components.
(D) The transfer of energy between different trophic levels in a food web.

253. Based on the description of ecosystem structure, which of the following would be classified as an abiotic component?
(A) Fungi breaking down dead organic matter.
(B) Algae performing photosynthesis in a pond.
(C) The salinity level of the water in an estuary.
(D) A herbivore grazing on a plant.

254. The paragraph implies that energy flow models would likely demonstrate which principle?
(A) An increase in available energy at higher trophic levels.
(B) The recycling of energy within the same trophic level.
(C) The creation of new energy by decomposers.
(D) A significant loss of energy between successive trophic levels.

255. What is the primary role of producers within the biotic structure of an ecosystem as described in the text?
(A) To decompose dead organic material and recycle nutrients.
(B) To consume other organisms for energy.
(C) To capture solar energy and convert it into a usable form for the ecosystem.
(D) To facilitate the movement of elements between abiotic and biotic realms.

Direction : Please read the following source carefully.

The complexity and functionality of ecosystems are further elucidated by concepts such as species diversity, ecotones, ecological habitats, and niches. Species diversity is a measure of the variety of different species within a community, contributing significantly to ecosystem stability. A stable ecosystem is one that can resist disturbance and recover quickly, with diversity being a key factor affecting this resilience. The concept of an ecotone refers to a transition area between two different biological communities, such as the zone between a forest and a grassland. These areas often exhibit 'edge effects,' where the ecotone hosts a greater density and diversity of species than either of the adjoining communities. An ecological habitat is the specific physical place where an organism lives, defined by its environmental conditions. In contrast, an ecological niche is a more comprehensive concept, describing not only the physical space an organism occupies but also its functional role within the ecosystem—its interactions, resource use, and contribution to energy flow. The distinction between habitat as an organism's 'address' and niche as its 'profession' is fundamental to understanding species interactions and resource partitioning. Furthermore, ecosystems provide numerous 'ecosystem services,' which are the benefits humans derive from properly functioning ecosystems, ranging from clean water and air to pollination and climate regulation.

Based on the above source, attempt the following five questions.

256. Which statement best distinguishes between an ecological habitat and an ecological niche?
(A) A habitat is the functional role of a species, while a niche is its physical address.
(B) A habitat is the physical place where an organism lives, while a niche encompasses its functional role and interactions.
(C) A habitat refers to a community of species, while a niche refers to a single organism.
(D) A habitat and a niche are synonymous terms for the environment an organism occupies.

257. The term 'edge effect' is most accurately associated with which of the following concepts?
(A) The central area of a large, uniform forest biome.
(B) An area of low species diversity due to environmental stress.
(C) The process of an ecosystem recovering after a major disturbance.
(D) The transition zone between two distinct biological communities.

258. According to the text, what is a primary factor affecting ecosystem stability?
(A) The level of species diversity within the community.
(B) The presence of a dominant keystone species.
(C) The rate of energy flow through the food web.
(D) The physical size of the geographical area.

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constant threat from factors like habitat loss, pollution, climate change, and overexploitation of resources. To prioritize conservation efforts, the concept of 'biodiversity hotspots' was developed. A hotspot is a biogeographic region that is both a significant reservoir of biodiversity and is under threat of destruction. The basis for identification of a hotspot typically involves two strict criteria: it must contain a high percentage of endemic plant species (species found nowhere else), and it must have lost a significant percentage of its original habitat. India is home to several of these critical hotspots, including the Western Ghats and the Eastern Himalayas, which are recognized globally for their unique and threatened assemblages of flora and fauna, making their conservation a high priority.

Based on the above source, attempt the following five questions.

271. What are the two primary criteria used for identifying a biodiversity hotspot?
(A) Large geographical area and high population of a single species.
(B) Presence of large charismatic megafauna and high tourism potential.
(C) High percentage of endemic species and significant habitat loss.
(D) Abundance of ecosystem services and low human population density.

272. The variation in genes within a single species, such as different breeds of dogs, is an example of which type of biodiversity?
(A) Ecosystem diversity
(B) Genetic diversity
(C) Species diversity
(D) Hotspot diversity

273. According to the paragraph, what is the significance of identifying regions like the Western Ghats in India as hotspots?
(A) It confirms these areas are completely safe from environmental threats.
(B) It designates them exclusively for economic development and resource extraction.
(C) It highlights their status as areas with low biodiversity requiring restoration.
(D) It prioritizes them for conservation efforts due to their unique and threatened biodiversity.

274. Which of the following is NOT listed in the paragraph as a major threat to biodiversity?
(A) The creation of national parks
(B) Habitat loss
(C) Overexploitation of resources
(D) Pollution

275. The term 'endemic species' is crucial for hotspot identification. What does it mean?
(A) A species that is a predator at the top of the food chain.
(B) A species that has been introduced from another region.
(C) A species that is found exclusively in one specific geographic area.
(D) A species that has a very large population and a wide distribution.

Direction : Please read the following source carefully.

The conservation of biodiversity is approached through various strategies, which can be broadly classified as in situ, ex situ, and in vitro. In situ (on-site) conservation is the primary strategy, focusing on conserving species in their natural habitats. This method involves the protection of whole ecosystems and is considered the most effective way to maintain the complex interactions and evolutionary processes of biological communities. Key examples of in situ conservation measures in India include the establishment of National Parks, Sanctuaries, and other Protected Areas. National Parks are typically designated for the protection of wildlife and their environment with restricted human activity, while Sanctuaries are often species-oriented with some human activities permitted. Sacred groves, which are patches of forest or natural vegetation dedicated to local deities, represent a traditional, community-based form of in situ conservation. In contrast, ex situ (off-site) conservation involves protecting components of biodiversity outside their natural habitats. This is often necessary for rare or endangered species and includes methods like captive breeding in zoological parks and seed banks for plants. In vitro conservation, a specialized form of ex situ preservation, involves the storage of biological material like cells or tissues in an artificial environment, typically under cryogenic conditions.

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(C) The geographic area occupied by a single individual of a species.
(D) The total number of species present within a specific ecosystem.

Direction : Please read the following source carefully.

Community ecology examines the organization and functioning of communities, which are assemblages of interacting populations of different species living in the same area. A central theme is the nature of species interactions, which can be categorized based on their effects on the participants. Predation is an interaction where one species, the predator, kills and consumes another, the prey. Herbivory is a specific form of predation where the organism consumes plants or algae. Parasitism is a symbiotic relationship where one organism, the parasite, benefits at the expense of another, the host, typically without immediately killing it. Another significant interaction is allelopathy, a form of interference competition where an organism produces biochemicals that influence the germination, growth, survival, and reproduction of other organisms. These interactions shape the structure and dynamics of the community. A particularly disruptive phenomenon in community ecology is biological invasion, which occurs when a non-native species is introduced to an ecosystem and its population proliferates, often causing significant harm to the native species and the overall ecological balance. The success of an invasive species can be attributed to factors like the absence of natural predators in the new environment and its ability to outcompete native organisms for resources.

Based on the above source, attempt the following five questions.

266. Which interaction involves one organism producing biochemicals to inhibit the growth of another?
(A) Predation
(B) Allelopathy
(C) Parasitism
(D) Herbivory

267. According to the text, biological invasion is considered a disruptive phenomenon primarily because it:
(A) Increases the overall species diversity of the community.
(B) Can cause significant harm to native species and ecological balance.
(C) Primarily involves the introduction of new predator species.
(D) Always leads to the immediate extinction of a native species.

268. What is the key difference between predation and parasitism as described in the paragraph?
(A) The predator typically kills its prey, while the parasite usually does not kill its host immediately.
(B) Predation involves animals, while parasitism involves only plants and fungi.
(C) Parasitism is a symbiotic relationship, whereas predation is not.
(D) Predation benefits one species, while parasitism harms both species involved.

269. Herbivory is presented in the text as a specific form of which broader interaction?
(A) Allelopathy
(B) Parasitism
(C) Predation
(D) Competition

270. A community, in the context of ecology, is best defined as:
(A) A group of individuals of the same species living in the same area.
(B) All the abiotic factors within a specific geographical location.
(C) The functional role of a single species within its environment.
(D) An assemblage of interacting populations of different species in a given area.

Direction : Please read the following source carefully.

Biodiversity, or biological diversity, is a broad term encompassing the variety of life on Earth at all its levels, from genes to ecosystems. It is commonly categorized into three types: genetic diversity (variety of genes within a species), species diversity (variety of species within a region), and ecosystem diversity (variety of ecosystems in a landscape). The importance of biodiversity is immense, contributing to ecosystem services, economic benefits, and aesthetic and cultural values. However, this vital resource is under

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with an indigenous tribe to study a medicinal plant, sharing the subsequent profits from a developed drug.

(C) A team of university scientists conducts a government-approved study on the genetic diversity of a fish population in a protected river.

(D) A country establishes a gene bank to preserve its native crop varieties for future agricultural research and development.

282. The primary goal of 'restoration ecology' is to:

(A) Search for commercially valuable products from nature.

(B) Assist the recovery of damaged or degraded ecosystems.

(C) Preserve genetic material in an off-site facility.

(D) Document the complete set of alleles within a species.

283. What is the fundamental difference between bio-prospecting and biopiracy?

(A) Bio-prospecting is illegal, while biopiracy is legal.

(B) Bio-prospecting involves ethical and authorized exploration with benefit-sharing, whereas biopiracy is unauthorized exploitation.

(C) Bio-prospecting focuses on animals, while biopiracy focuses on plants.

(D) Bio-prospecting is a form of conservation, while biopiracy is a form of restoration.

284. The concept of a 'gene pool' refers to:

(A) The complete set of genetic information within a population or species.

(B) An area of land set aside for ecosystem restoration.

(C) The total variety of ecosystems in a given landscape.

(D) The unauthorized use of genetic resources for commercial gain.

285. The practice of bio-prospecting is described as:

(A) The unethical appropriation of indigenous knowledge.

(B) The scientific study of renewing destroyed habitats.

(C) The systematic search for valuable products from nature.

(D) The complete documentation of all genes in a species.

Direction : Please read the following source carefully.

Toxicology is the scientific discipline concerned with the adverse effects of chemical, physical, or biological agents on living organisms and the ecosystem. A key aspect is toxicokinetics, which includes the absorption, distribution, and excretion of toxic agents within an organism. Once absorbed, a toxicant is distributed throughout the body, and the body attempts to eliminate it through excretion or render it less harmful through biotransformation. The manifestation of toxicity can be acute, resulting from a single, short-term exposure, or chronic, arising from repeated or long-term exposure to lower concentrations. To quantify toxicity, the concept of a bioassay is used, which measures the effects of a substance on living organisms. From such studies, regulatory values are derived. The threshold limit value (TLV) refers to the concentration of a substance in the air to which it is believed a worker can be exposed day after day for a working lifetime without adverse effect. The margin of safety is a ratio that compares a therapeutically effective dose to a dose that produces toxic effects. In pharmacology, the related therapeutic index is used to measure the relative safety of a drug, representing the ratio of the dose that produces toxicity to the dose that produces a clinically desired response.

Based on the above source, attempt the following five questions.

286. Which term describes the process by which an organism's body modifies a toxic agent, often to render it less harmful?

(A) Absorption

(B) Excretion

(C) Distribution

(D) Biotransformation

287. A factory worker develops a severe illness after a single, massive exposure to a chemical spill. This would be classified as:

(A) Chronic toxicity

(B) A therapeutic effect

(C) Acute toxicity

(D) A high threshold limit value

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Based on the above source, attempt the following five questions.

276. Establishing a seed bank to preserve the genetic material of various crop plants is an example of which conservation strategy?
(A) Ex situ conservation
(B) In situ conservation
(C) Community-based conservation
(D) Landscape-level conservation

277. The paragraph identifies Sacred groves in India as an example of:
(A) An ex situ conservation technique involving cryopreservation.
(B) A government-managed National Park with high security.
(C) A designated area for captive breeding of endangered animals.
(D) A traditional, community-based approach to in situ conservation.

278. What is the fundamental principle of in situ conservation?
(A) Protecting species by removing them from their threatened natural habitats.
(B) Conserving species within their natural ecosystems and habitats.
(C) Storing genetic material in an artificial laboratory environment.
(D) Focusing conservation efforts exclusively on economically important species.

279. Based on the descriptions, what is a key difference between a National Park and a Sanctuary in India?
(A) National Parks are for plant conservation, while Sanctuaries are for animals.
(B) National Parks are examples of ex situ conservation, whereas Sanctuaries are in situ.
(C) Sanctuaries allow for more human activities compared to the stricter regulations in National Parks.
(D) Sanctuaries are managed by local communities, while National Parks are managed by international bodies.

280. In vitro conservation is described as a specialized technique that involves:
(A) The protection of an entire ecosystem like a tropical rainforest.
(B) The breeding of animals in a zoological park.
(C) The legal protection of a specific area through government legislation.
(D) The preservation of biological tissues or cells in an artificial environment.

Direction : Please read the following source carefully.

Beyond the fundamental strategies of conservation, several specific concepts shape the discourse on biodiversity management, including gene pool, biopiracy, bio-prospecting, and restoration ecology. The gene pool refers to the complete set of unique alleles or genetic information within a population or species; its diversity is critical for adaptation and long-term survival. The concepts of biopiracy and bio-prospecting address the exploration and utilization of biological resources. Bio-prospecting is the legitimate and systematic search for valuable chemicals, genes, and other products from nature, which can lead to the development of new medicines and technologies, ideally with equitable benefit-sharing with the source communities. In stark contrast, biopiracy is the appropriation and often patenting of indigenous knowledge and genetic resources without proper authorization or compensation to the communities or countries from which they originate. It represents an unethical and often illegal exploitation of biodiversity. Parallel to these issues is the concept of restoration ecology, which is the scientific study of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats. This applied science aims to assist the recovery of ecosystem health, integrity, and sustainability, often by reintroducing native species and re-establishing ecological processes that have been lost.

Based on the above source, attempt the following five questions.

281. Which of the following scenarios best exemplifies 'biopiracy'?
(A) A corporation patents a chemical compound derived from a traditional medicinal herb without acknowledging or compensating the local community that has used it for generations.
(B) A pharmaceutical company collaborates

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(A) More effective for all types of contaminants.
(B) Less disruptive to the site and generally more cost-effective.
(C) Faster and provides more controlled conditions.
(D) Only method that uses microorganisms.

295. The definition of 'bioremediation' provided in the text centers on the use of:
(A) Chemical reactions to neutralize pollutants.
(B) Physical barriers to contain contaminants.
(C) Living organisms to degrade or detoxify contaminants.
(D) High temperatures to incinerate waste materials.

Direction : Please read the following source carefully.

Beyond remediation, environmental biotechnology encompasses a range of tools that utilize biological processes for monitoring and sustainable development. Bioindicators are organisms, species, or biological communities whose presence, abundance, or condition can be used to assess environmental health and quality. For example, the presence or absence of certain lichen species can indicate levels of air pollution. In agriculture, biofertilizers are substances containing living microorganisms which, when applied to seed, plant surfaces, or soil, colonize the rhizosphere and promote growth by increasing the supply of primary nutrients to the host plant. They offer an eco-friendly alternative to synthetic fertilizers. The quest for renewable energy has led to the development of biofuels, which are fuels derived directly from living matter, such as agricultural crops or algae. These can reduce reliance on fossil fuels, though their production raises debates about land use and food security. Another innovative application is the biosensor, an analytical device that combines a biological component (like an enzyme or antibody) with a physicochemical detector. Biosensors are used for rapid and specific detection of substances, from pollutants in a river to glucose in a blood sample, providing a powerful tool for environmental monitoring and medical diagnostics.

Based on the above source, attempt the following five questions.

296. Which of the following best describes the function of a bioindicator?
(A) A fuel derived from recently living biological matter.
(B) A device that uses a biological component to detect a specific chemical.
(C) A substance containing microbes that enhances soil fertility.
(D) An organism whose condition reflects the health of its environment.

297. A biosensor is characterized by the combination of:
(A) A biological component and a physicochemical detector.
(B) A biofuel and a biofertilizer.
(C) An in situ and an x situ remediation technique.
(D) A plant species and a microbial community.

298. What is the primary purpose of using biofertilizers in agriculture?
(A) To directly kill insect pests that damage crops.
(B) To promote plant growth by increasing nutrient availability through microbial action.
(C) To monitor the level of air pollution in the vicinity of the farm.
(D) To convert agricultural waste into renewable energy.

299. According to the text, biofuels are derived from:
(A) The process of bioremediation of toxic waste.
(B) Living matter such as crops or algae.
(C) Synthetic chemical reactions in a laboratory.
(D) Fossilized organic material from ancient ecosystems.

300. Observing the decline of a specific lichen community on trees to assess air quality is a practical application of which concept?
(A) A bioindicator
(B) Biofuel production
(C) A biosensor
(D) A biofertilizer

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288. The 'threshold limit value (TLV)' is a benchmark primarily used in the context of:
(A) The safety of pharmaceutical drugs for patients.
(B) Occupational exposure to airborne substances in a workplace.
(C) The concentration of a waterborne pathogen.
(D) The measurement of acute toxicity in a laboratory animal.

289. The purpose of a 'bioassay' in toxicology is to:
(A) Determine the chemical structure of a toxic agent.
(B) Purify a toxic substance from a contaminated sample.
(C) Calculate the rate of excretion of a substance from the body.
(D) Measure the effects of a substance on living organisms.

290. How is the 'therapeutic index' of a drug generally interpreted?
(A) A higher therapeutic index suggests a greater margin of safety between effective and toxic doses.
(B) A lower therapeutic index indicates a safer drug.
(C) A higher therapeutic index indicates that a drug is more effective.
(D) The therapeutic index measures the speed of absorption of a drug.

Direction : Please read the following source carefully.

Environmental biotechnology leverages biological systems for environmental protection and remediation. A cornerstone of this field is bioremediation, defined as the use of living organisms, primarily microbes and plants, to degrade or detoxify environmental contaminants. Bioremediation strategies are categorized based on where they are applied. In situ bioremediation involves treating contaminated material at its original site, which is less disruptive and often more cost-effective. This can be enhanced by adding nutrients or oxygen to stimulate the activity of native microorganisms. In contrast, ex situ bioremediation requires the excavation and removal of contaminated soil or water to a separate facility for treatment, allowing for more controlled conditions but at a higher cost and with greater site disruption. Plants play a crucial role in a process known as phytoremediation, a type of in situ treatment where they can absorb, accumulate, or break down contaminants. Microbes are the workhorses of bioremediation, possessing diverse metabolic capabilities to transform a wide array of pollutants, including petroleum hydrocarbons and chlorinated solvents, into less harmful substances. This biological approach offers a sustainable alternative to conventional physicochemical methods for cleaning up polluted environments.

Based on the above source, attempt the following five questions.

291. Which of the following scenarios describes in situ bioremediation?
(A) Contaminated soil is excavated and transported to a landfill.
(B) A chemical oxidizing agent is injected into the ground to destroy a pollutant.
(C) Nutrients are pumped into a contaminated aquifer to stimulate native bacteria to degrade a pollutant.
(D) Polluted water is pumped out of the ground and treated in a bioreactor before being discharged.

292. What is the primary difference between in situ and ex situ bioremediation?
(A) In situ treats contaminants on-site, while ex situ involves moving the contaminated material for treatment.
(B) In situ uses plants, while ex situ uses microbes.
(C) In situ is always faster than ex situ.
(D) In situ is used for water pollution, while ex situ is used for soil pollution.

293. The use of plants to absorb and accumulate heavy metals from contaminated soil is a specific application of:
(A) Industrial ecology
(B) Biotransformation
(C) Ex situ microbial treatment
(D) Phytoremediation

294. According to the text, the main advantage of in situ bioremediation over ex situ methods is that it is:

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through the biological, geological, and chemical components of the earth. Elements like carbon, nitrogen, and phosphorus transition between living organisms and the atmosphere, hydrosphere, or lithosphere. These pathways ensure that vital nutrients are not lost but are recycled through the ecosystem, maintaining the necessary balance required for all life forms to survive.

9. (B) Both Statement I and Statement II are false.
Primary succession begins in completely barren areas where no soil exists, such as bare rocks or new volcanic islands. In contrast, secondary succession occurs in regions where an existing community has been disturbed or removed but the soil remains intact. Both processes represent the predictable transition of species over time, eventually leading to a stable climax community that is characteristic of the local climate and geography.

10. (A) Species diversity
Species diversity is a critical measure of an ecosystem's health, encompassing both the total number of different species present and the relative abundance of each. High diversity often indicates a more stable and resilient environment capable of withstanding various disturbances. This concept differs from simple species richness by considering how evenly individuals are distributed across the different types of organisms within a biological community.

11. (A) Both A and R are true and R is the correct explanation of A.
An ecotone serves as a transition area between two distinct biological communities, such as a forest and a grassland. Because it blends characteristics of both environments, it typically supports a higher variety of species than either individual habitat. This biological phenomenon occurs because the zone attracts organisms from both adjacent ecosystems while providing unique conditions that support specialized species adapted to the edge environment.

12. (B) Ecological niche
An ecological niche describes the specific functional role an organism plays within its community, encompassing its habitat, resource use, and interactions with other species. It details how an organism obtains energy and what other creatures depend on it for survival. Unlike a habitat, which is merely a physical location, the niche represents the complete set of conditions and resources a species requires to thrive.

13. (C) Regular and severe disturbances
Ecosystem stability is enhanced by factors like high species diversity and complex food webs, which provide multiple pathways for energy flow. Regular and severe disturbances, however, tend to disrupt these established connections and prevent the system from maintaining a steady state. While some disturbance can promote diversity, extreme or frequent events often lead to a loss of resilience and a decline in overall biological productivity.

14. (A) P-2, Q-1, R-4, S-3
Ecosystem services are categorized into four main types based on the benefits they provide to humans. Provisioning services include tangible goods like food and water, while regulating services involve processes like climate control. Cultural services encompass non-material benefits such as recreation and spiritual value. Finally, supporting services, including nutrient cycling and soil formation, are necessary for the production of all other essential natural ecosystem services.

15. (A) Geographic location and dominant life forms.
Ecosystems are primarily classified based on their geographic location and the dominant life forms found within them. This classification system considers the prevailing climate, soil type, and the characteristic vegetation that defines the landscape. By categorizing environments this way, scientists can study the similarities and differences in how energy is processed and nutrients are recycled across diverse terrestrial and aquatic habitats found worldwide.

16. (B) High temperatures and low precipitation.
Hot deserts are specialized ecosystems defined by extreme high temperatures and very low annual precipitation. These harsh conditions limit the types of vegetation that can survive, favoring succulent plants and species with water-conserving adaptations. The lack of moisture significantly impacts the nutrient cycling and energy flow within the system, resulting in a

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ANSWERS

1. (B) The study of interactions between organisms and their environment.
Ecology integrates biological, chemical, and physical sciences to understand how living beings relate to their surroundings. It examines the complex web of life, focusing on how energy flows and nutrients cycle between organisms and the non-living parts of the earth. This broad approach allows scientists to address environmental challenges by considering the biological requirements of species alongside the physical constraints of their specific habitats.

2. (A) The origin of life and the formation of new species.
Speciation represents the evolutionary process by which populations evolve to become distinct species. This fundamental mechanism increases biological diversity on earth and is intricately linked to the origin of life through lineage divergence. It occurs when groups within a species become reproductively isolated, leading to the accumulation of genetic differences over time. Understanding this process is vital for studying evolutionary biology and the history of life.

3. (C) It examines relationships between human populations and environments.
Human ecology explores the intricate and dynamic relationships between human societies and the natural environments they inhabit. This field investigates how people adapt to their surroundings and how human activities, such as urbanization and resource extraction, alter ecological systems. It combines sociological perspectives with environmental science to understand the sustainability of human settlements and the long-term impact of human populations on global biological diversity.

4. (D) It is defined by the interaction of biotic and abiotic components.
An ecosystem is fundamentally defined by the complex interactions between its living organisms and the non-living environment. The biotic component includes all producers, consumers, and decomposers, while the abiotic component comprises physical and chemical factors like sunlight, temperature, and soil minerals. The structural integrity of an ecosystem depends on the continuous exchange of matter and energy among these diverse and interconnected biological and physical components.

5. (C) To break down dead matter and return nutrients to the system.
Decomposers are essential organisms that sustain ecosystem health by recycling organic material. By breaking down the remains of dead plants and animals, they facilitate the return of vital nutrients to the soil or water, making them available once again for primary producers. This process prevents the accumulation of waste and ensures the continuity of nutrient cycles, supporting the overall productivity and balance of the environment.

6. (B) Dead leaves → Bacteria → Protozoa
A detritus food chain begins with dead organic matter, which serves as the primary energy source for decomposers. In this specific sequence, fallen leaves provide nutrients for bacteria, which are then consumed by protozoa. Unlike grazing food chains that start with living plants, detritus chains play a critical role in nutrient recycling and energy transfer from waste products back into the active biotic community.

7. (B) I and III only
Energy flow in ecosystems is characterized by a unidirectional movement from primary producers to successive trophic levels. While energy is transferred through various organisms, a significant portion is lost as heat at each step, preventing a continuous gain. Quantitative models help illustrate these energy relationships, showing how the sun serves as the primary source for most biological systems, rather than energy from geothermal heat.

8. (A) A biogeochemical cycle
Biogeochemical cycles represent the continuous movement of essential chemical elements

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259. Based on the paragraph, which of the following is an example of an 'ecosystem service'?
(A) The construction of a dam for hydroelectric power.
(B) The application of chemical fertilizers to agricultural fields.
(C) The natural filtration of water by a wetland ecosystem.
(D) The introduction of a non-native species to control pests.

260. An ecotone is described as an area that often has:
(A) A greater density and diversity of species compared to the adjoining communities.
(B) Lower species density than the adjacent communities.
(C) Identical species composition to one of the adjoining ecosystems.
(D) A complete absence of species from the neighboring communities.

Direction : Please read the following source carefully.

Population ecology studies the dynamics of species populations and how these populations interact with the environment. A population is characterized by attributes such as density, birth rate, death rate, and age structure. The concept of carrying capacity (K) is central, representing the maximum population size of a species that the environment can sustain indefinitely, given the available resources. Population growth patterns and their regulation are key areas of focus. Growth can be exponential under ideal conditions but is typically regulated by density-dependent factors (like competition and predation) and density-independent factors (like climate events). Populations also exhibit fluctuations, dispersion patterns (clumped, uniform, or random), and can exist as metapopulations—a network of semi-isolated populations connected by migration. The concepts of 'r' and 'k' species describe two contrasting life history strategies. 'r'-selected species, such as insects, typically have high growth rates, produce many offspring, and thrive in unstable environments. Conversely, 'k'-selected species, like large mammals, live near the carrying capacity, have lower reproductive rates, and invest heavily in their few offspring. Another crucial concept is that of a keystone species, which has a disproportionately large effect on its environment relative to its abundance, often maintaining the structure and integrity of the community.

Based on the above source, attempt the following five questions.

261. Which of the following characteristics is most representative of a 'k'-selected species?
(A) Thriving in unstable and unpredictable environments.
(B) A high intrinsic rate of population growth.
(C) Production of a large number of offspring with minimal parental care.
(D) Living near the environment's carrying capacity with high investment in offspring.

262. A 'keystone species' is defined by its:
(A) High population density relative to other species in the community.
(B) Disproportionately large impact on the community structure relative to its abundance.
(C) Position at the very top of the food chain as an apex predator.
(D) Ability to exist as a network of semi-isolated metapopulations.

263. A disease that spreads more rapidly in a dense population of rodents than in a sparse one is an example of:
(A) A density-independent regulatory factor.
(B) A 'k'-selection life history strategy.
(C) A density-dependent regulatory factor.
(D) A random dispersion pattern.

264. The term 'metapopulation' describes:
(A) The maximum population size an environment can sustain.
(B) A single, isolated population with no interaction with others.
(C) The spatial arrangement of individuals within a single population.
(D) A network of spatially separated populations connected by migration.

265. What does the concept of 'carrying capacity (K)' signify in population ecology?
(A) The maximum population size that an environment can sustainably support.
(B) The intrinsic rate of increase of a population under ideal conditions.

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unique biological community characterized by specialized survival strategies and limited annual biodiversity.

17. (B) A lake
Lentic ecosystems are characterized by standing or relatively still bodies of water, such as lakes, ponds, and wetlands. These environments differ significantly from flowing water systems because they allow for the accumulation of sediments and different thermal stratification patterns. The lack of a strong current influences the types of organisms that can inhabit these areas, favoring species adapted to calm conditions rather than flow.

18. (C) Estuarine (Mangrove)
Estuarine ecosystems occur where freshwater from rivers mixes with saltwater from the ocean, creating a unique brackish environment. These areas are characterized by halophytic vegetation, such as mangroves, which have adapted to high salinity levels. They serve as vital nurseries for many marine species, providing shelter and abundant nutrients. This interface between land and sea plays a crucial role in coastal protection and regional biodiversity.

19. (C) Oceanic
Oceanic ecosystems encompass the vast, open waters of the world's oceans, far from the coastal shelves. These deep-water environments support pelagic organisms that live in the water column rather than on the sea floor. The structure and function of these systems are driven by light penetration, temperature gradients, and nutrient availability, making them critical for global climate regulation and supporting a significant portion of life.

20. (D) A large area defined by climate and distinct communities.
A biome is a large-scale ecological unit characterized by distinct climate patterns and specific communities of plants and animals. Unlike smaller ecosystems, biomes are defined by broad environmental factors like temperature and precipitation, which determine the types of vegetation that can grow. Common examples include tropical rainforests, deserts, and tundras, each representing a unique combination of biological and physical characteristics across geographic regions.

21. (C) Tundra
The tundra biome is characterized by extremely cold temperatures, very low precipitation, and a permanently frozen layer of subsoil known as permafrost. These harsh conditions prevent the growth of deep-rooted trees, resulting in a landscape dominated by low-growing vegetation like mosses, lichens, and small shrubs. This biome exhibits short growing seasons and supports specialized animals adapted to surviving in some of the coldest environments.

22. (B) Coniferous trees like pine, spruce, and fir.
The taiga biome, also known as the boreal forest, is the world's largest terrestrial biome and is dominated by coniferous trees like pine, spruce, and fir. Located south of the tundra, it experiences long, cold winters and short, cool summers. The needle-like leaves of its trees are an adaptation to conserve water and survive freezing temperatures, making it a distinct and resilient forest ecosystem.

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23. (D) The soil is extremely rich in nutrients.
Tropical rain forests are known for their extraordinary biodiversity and dense, multi-layered canopies that receive high annual rainfall. However, contrary to common belief, the soil in these ecosystems is typically nutrient-poor. This occurs because the warm, moist conditions facilitate rapid decomposition and immediate nutrient uptake by the dense vegetation. Consequently, most of the ecosystem's nutrients are stored in the living biomass rather than soil.

24. (A) Both A and R are true and R is the correct explanation of A.
Trees in deciduous forests have developed a specific adaptation to survive seasonal changes by shedding their leaves annually. This process typically occurs before the onset of cold or dry seasons, allowing the trees to minimize water loss through transpiration and conserve precious energy. By entering a dormant state, these organisms can withstand unfavorable environmental conditions, ensuring their survival until warmer temperatures and adequate moisture return.

increasing the availability of essential nutrients. A prominent example is Rhizobium bacteria, which form a symbiotic relationship with legume roots to fix atmospheric nitrogen into a form plants can use. Unlike chemical fertilizers, biofertilizers improve soil health and fertility sustainably without causing environmental pollution. They are an integral component of sustainable organic farming.

60. (B) Biosensor
A biosensor is an analytical device that combines a biological component, such as an enzyme or antibody, with a physical transducer to detect specific chemical substances. When the biological element interacts with the target molecule, it produces a signal that is converted into a measurable output. These devices are widely used in environmental monitoring to detect pollutants and in medicine for rapid diagnostics of agents.

61. (C) The amount of annual rainfall
Abiotic components are the non-living physical and chemical parts of an ecosystem that influence living organisms. In a forest, annual rainfall is a primary abiotic factor that determines the types of vegetation that can grow and the overall productivity of the habitat. While trees, animals, and fungi are biotic components, environmental factors like light, temperature, and moisture provide the necessary framework for life to exist.

62. (D) Producers
In a typical energy pyramid, the base is always occupied by primary producers, such as plants and algae, which have the largest total biomass. These organisms capture solar energy through photosynthesis, forming the foundation for all other life in the ecosystem. As energy is transferred to higher trophic levels, like consumers, a significant portion is lost at each step. Consequently, the biomass decreases significantly.

63. (B) P-2, Q-4, R-1, S-3
Biomes are defined by their unique combinations of vegetation and climate. Grasslands are dominated by various grasses with moderate rainfall, while chaparral features sclerophyllous shrubs adapted to dry summers. Highland alpine regions are found at high altitudes and are characterized by low temperatures and a lack of trees. Savannas consist of grassy landscapes with scattered trees and distinct seasonal shifts, illustrating terrestrial diversity.

64. (B) Edge effect
The edge effect describes the significant changes in species composition and environmental conditions that occur at the boundary between two different habitats. These transitional zones often have higher biodiversity because they contain species from both adjacent ecosystems along with unique organisms adapted specifically to the edge. This phenomenon is critical in conservation, as habitat fragmentation increases the amount of edge area, potentially altering stability.

65. (B) Resistance (Stability)
Ecosystem resistance is the capacity of a natural system to withstand disturbances without undergoing significant changes in its structure or function. A resistant ecosystem can maintain its internal balance despite external pressures like pollution or invasive species. This property is closely related to stability and is often enhanced by high biodiversity, which provides redundant ecological roles. Understanding resistance helps predict response to stressors.

66. (A) Extreme cold winters, hot summers, and sparse vegetation.
Cold deserts, such as the one found in the Ladakh region, are characterized by extreme temperature fluctuations, with very cold winters and relatively hot summers. These areas receive very little precipitation, often as snow, leading to a sparse cover of drought-resistant vegetation. The harsh climate and poor soil quality limit biological productivity, creating a unique and fragile ecosystem where specialized organisms have adapted to survive.

67. (C) Wetland - Saturated soil and hydrophytic vegetation.
Wetlands are unique ecosystems where the soil is either permanently or seasonally saturated with water, supporting hydrophytic vegetation adapted to these wet conditions. They play a vital role in water purification and flood control. In contrast, lotic systems refer to flowing waters, and rangelands are characterized by open grazing lands. Understanding these defining features is

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a negative effect for the prey, which loses its life. This dynamic is a primary driver of energy flow in food webs and significantly influences the population sizes and evolution.

34. (A) Parasitism
Parasitism is a non-mutual relationship between species where one organism, the parasite, lives on or inside another organism, the host. The parasite benefits by deriving nutrients at the host's expense, often causing harm or disease without immediately killing it. This interaction is common across all kingdoms of life and plays a significant role in regulating host populations and driving the evolution of immunity.

35. (C) Allelopathy
Allelopathy is a biological phenomenon where an organism produces biochemicals that influence the growth, survival, or reproduction of other organisms. This process is often used by plants to gain a competitive advantage by inhibiting the germination or development of nearby competing species. These chemical interactions can significantly alter the composition of plant communities and are an important factor in understanding succession and biological invasions.

36. (B) I, II, IV, III
The history of life on earth began with the origin of life in simple forms, followed by the evolution of complex eukaryotic cells. Over time, organisms transitioned from aquatic environments to land, with plants and animals colonizing terrestrial habitats. Finally, the process of speciation led to the emergence of modern humans. This sequence reflects the increasing complexity and diversification of biological systems throughout geological history.

37. (C) Invasive species
Invasive species are non-native organisms that, when introduced to a new environment, cause significant ecological or economic damage. Because they often lack natural predators in their new habitat, they can reproduce rapidly and outcompete native species for essential resources like food and space. This disruption can lead to a decline in local biodiversity, alter ecosystem functions, and result in substantial management and restoration costs.

38. (B) Geological diversity
Biodiversity is typically categorized into three primary levels: genetic, species, and ecosystem diversity. Genetic diversity refers to the variation within a species, while species diversity considers the variety of different organisms. Ecosystem diversity involves the range of habitats and ecological processes. Geological diversity, while important for understanding the earth's physical history, is not considered a biological component of biodiversity, which focuses on living systems.

39. (D) High number of endemic species and a high degree of threat.
Biodiversity hotspots are specific geographic regions that contain exceptionally high levels of species found nowhere else on earth, known as endemic species. To be designated as a hotspot, an area must also be under significant threat, having lost a large portion of its original natural habitat. This concept helps conservationists prioritize regions where urgent action is required to prevent the loss of unique biological heritage.

40. (B) I, II, and III only
Biodiversity is fundamental to ecosystem productivity and stability, providing essential services like nutrient cycling and climate regulation. However, it faces severe threats from habitat loss, pollution, and climate change. Regions like the Western Ghats in India are vital biodiversity hotspots due to their high endemism and level of threat. Contrary to common beliefs, high biodiversity is typically associated with tropical regions rather than polar areas.

41. (C) A national park
In situ conservation involves protecting species within their natural habitats, allowing them to interact with their environment and continue their evolutionary processes. Establishing national parks is a primary strategy for this approach, as it secures large areas of land to preserve entire ecosystems and the diverse organisms they support. By protecting the habitat itself, conservationists can ensure the long-term survival of multiple species simultaneously.

42. (A) Outside the natural habitat of the species.
Ex situ conservation refers to the practice of protecting endangered species outside their natural environments. This approach is often

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25. (C) A grassland with scattered trees and wet/dry seasons.
The savanna biome is a tropical grassland characterized by a warm climate and distinct wet and dry seasons. It features a continuous cover of grasses with scattered individual trees or small groves. This ecosystem is maintained by periodic fires and grazing by large herbivores, which prevent the establishment of dense forests. Savannas support a diverse array of wildlife and are vital for carbon storage.

26. (A) Population density
Population density is a fundamental characteristic used to describe the number of individuals of a single species per unit area or volume. This metric helps ecologists understand the distribution and abundance of organisms within a specific habitat. Unlike community-level traits like species diversity or ecosystem-level processes like energy flow, population density focuses on the internal dynamics and resource competition within a biological group.

27. (B) II and III only
Population characteristics include dispersion, which describes how individuals are spatially arranged, and carrying capacity, representing the maximum population size an environment can sustain. Other factors like natality refer to birth rates rather than death rates. Additionally, age structure is a vital characteristic used to predict future growth. Metapopulations consist of multiple connected populations, highlighting the complexity of biological groups found in fragmented habitats.

28. (B) Logistic growth model
The logistic growth model describes how a population's increase slows down as it approaches the carrying capacity of its environment. Initially, growth may be rapid, but as resources like food and space become limited, the rate of growth levels off. This results in an S-shaped curve, illustrating the balance between a species' reproductive potential and the environmental resistance encountered as populations reach sustainable sizes.

29. (C) An 'r' species
Species classified as 'r-strategists' are adapted to exploit unstable or newly formed environments through rapid reproduction and high growth rates. They typically have short life spans, mature quickly, and produce a large number of offspring with minimal parental care. These opportunistic organisms are efficient colonizers, allowing them to establish populations in unpredictable habitats before competition increases or the environment changes, ensuring species persistence.

30. (D) Elephant
'K-selected' species are characterized by their ability to maintain stable populations near the carrying capacity of their environment. They typically have long life spans, slow development, and produce fewer offspring but invest heavily in parental care. Large mammals, like elephants, are classic examples of this strategy, as they thrive in stable habitats where competition is intense and the survival of individual offspring is critical.

31. (A) P-3, Q-2, R-1, S-4
Population ecology uses specific terms to describe the dynamics of biological groups. A metapopulation consists of semi-isolated groups connected by migration, while dispersion refers to the spatial arrangement of individuals. Carrying capacity represents the maximum sustainable population size determined by available resources. Furthermore, 'r' species are opportunistic organisms that exhibit high growth rates and rapid colonization, highlighting different reproductive strategies used by life.

32. (B) A species with high impact relative to its abundance.
A keystone species plays a critical role in maintaining the structure and integrity of its ecological community. Despite often having a relatively low abundance, its presence or absence significantly alters the environment and the populations of other species. By influencing the availability of resources or controlling the numbers of other organisms, keystone species prevent any single species from dominating, ensuring high biodiversity and stability.

33. (B) Predation
Predation is a biological interaction where one organism, the predator, kills and consumes another organism, the prey. This relationship is characterized by a positive effect for the predator, which gains energy and nutrients, and

potentially causing harm to different organs. Understanding how substances are absorbed is fundamental to toxicology, as it determines the amount of toxin.

51. (C) A is true but R is false.
Chronic toxicity refers to the adverse health effects that develop following prolonged or repeated exposure to a toxicant over an extended period. Unlike acute toxicity, which appears immediately, the consequences of chronic exposure often take months or even years to become evident as damage accumulates in the body. Therefore, the effects are typically not apparent after the first exposure, making identification difficult without monitoring.

52. (D) To measure activity via its effect on living organisms.
A bioassay is a scientific procedure used to determine the concentration or potency of a substance by observing its effects on living cells or organisms. This method is particularly useful in toxicology for assessing the potential harm of chemicals when their structure is unknown. By measuring biological responses, such as mortality, researchers can quantify the toxicity of a substance and establish safe limits for exposure.

53. (C) Threshold Limit Value (TLV)
The Threshold Limit Value (TLV) is an occupational health standard that defines the maximum concentration of a chemical in the air that a worker can be exposed to daily without adverse effects. This value assumes a standard working lifetime and is designed to protect employees from both acute and chronic toxicity. Establishing TLVs is essential for maintaining safe working environments and preventing long-term illness.

54. (B) Metabolic conversion, often to water-soluble forms.
Biotransformation is the metabolic process by which a toxic agent is chemically altered within the body, primarily by the liver. The goal of this process is often to convert lipid-soluble toxins into more water-soluble forms, which can then be easily excreted through urine or bile. While this usually detoxifies the substance, it can sometimes produce more harmful metabolites. This chemical change is critical.

55. (D) Cholera
Cholera is a severe water-borne disease caused by the ingestion of contaminated water or food containing the bacterium Vibrio cholerae. It is characterized by acute diarrhea and dehydration, which can be fatal if not treated promptly. Preventing cholera requires ensuring access to clean drinking water and proper sanitation systems to eliminate the spread of bacteria. This disease remains a significant public health challenge worldwide.

56. (A) Bioremediation
Bioremediation is an environmentally friendly technology that uses living organisms, such as bacteria, fungi, or plants, to remove or neutralize pollutants from contaminated soil and water. These organisms metabolize harmful substances, often breaking them down into non-toxic compounds like carbon dioxide and water. This approach is highly effective for treating oil spills and chemical wastes, providing a cost-effective alternative to traditional mechanical cleanup.

57. (B) I, II, and III only
Bioremediation involves the use of organisms to treat environmental contaminants either at the original site or by removing the material for external treatment. Phytoremediation is a specific type that utilizes plants to extract or stabilize pollutants. While very effective for organic compounds, bioremediation can also be used for heavy metals, though the process often involves stabilization. These strategies allow for flexible management of pollution.

58. (A) Bioindicator
A bioindicator is a species whose presence, absence, or general health reflects the quality of its environment. Because certain organisms are highly sensitive to specific pollutants or changes in their habitat, they serve as early warning systems for ecological damage. For example, lichens are indicators of air quality, while aquatic insects reveal the health of water systems. Monitoring these species allows for assessment of environment.

59. (D) Rhizobium bacteria that fix atmospheric nitrogen.
Biofertilizers are substances containing living microorganisms that enhance plant growth by

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new and distinct species evolve from existing populations through mechanisms like natural selection and genetic drift. By examining fossil records and genetic data, biologists reconstruct history, providing a framework for understanding complex biological diversity today.

93. (C) Resilience
Ecosystem resilience refers to the capacity of a natural system to recover its original structure and function after being disturbed by events like fires or human activities. A highly resilient ecosystem can bounce back quickly, maintaining its productivity and biodiversity. This property is vital for survival in a changing environment and is supported by high species diversity, which ensures multiple organisms fulfill essential ecological roles.

94. (D) Parks have higher protection where most human activities are prohibited.
In India, both national parks and wildlife sanctuaries are protected areas, but they differ in their level of regulation. National parks generally offer a higher degree of protection, where most human activities, including resource collection, are strictly prohibited to preserve the pristine environment. Sanctuaries are more flexible, often allowing limited traditional activities provided they do not interfere with conservation. These designations help balance environmental protection.

95. (C) Statement I is true, but Statement II is false.
The concept of a gene pool accurately refers to the total collection of genes within a specific population, which is essential for evolutionary adaptation. However, the definition of biopiracy as an equitable exploration is incorrect. Biopiracy involves the unauthorized exploitation of biological resources or traditional knowledge for commercial gain. True equitable exploration is known as bio-prospecting, which aims for sustainable use and fair benefit-sharing among stakeholders.

96. (B) Exponential growth
Exponential growth is characterized by a population increasing at a constant rate over time, resulting in a distinct J-shaped curve when graphed. This type of growth typically occurs in environments with abundant resources and little to no competition or predation. However, such rapid increase is usually unsustainable in the long term, as the population will eventually encounter environmental resistance or deplete resources, leading to stabilization.

97. (A) Both A and R are true and R is the correct explanation of A.
Biological invasions by non-native species are a significant threat to global biodiversity because they disrupt established ecological balances. These invasive organisms often lack natural predators and can rapidly outcompete native species for essential resources like food and nesting sites. Additionally, they may introduce new diseases or significantly alter the physical habitat, causing declines in native populations. Protecting ecosystems from these invasions is a top priority.

98. (A) Climate regulation
Regulating ecosystem services are the natural processes that maintain environmental conditions necessary for life. Climate regulation is a primary example, as ecosystems like forests and oceans absorb greenhouse gases, helping to stabilize global temperatures. Other regulating services include water purification, pollination, and pest control. These invisible benefits are crucial for human well-being and species survival, as they provide a stable and healthy environment.

99. (C) Adverse effects occurring shortly after single or multiple doses.
Acute toxicity refers to the immediate adverse effects that occur within a short period after a single or multiple exposures to a toxic substance. These consequences are typically severe and can be identified quickly following contact with a hazardous chemical. Understanding acute toxicity is vital for emergency response and setting safety limits. It differs from chronic toxicity, which results from long-term exposure and develops slowly.

100. (B) Taiga
The taiga, also known as the boreal forest, is characterized by vast coniferous forests and experiences long, cold winters with short summers. Located south of the tundra, this biome has acidic and mineral-poor soils due to slow decomposition of needles. These unique

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essential for classifying and managing different natural environments and protecting biodiversity.

68. (D) Density-dependent factors
Density-dependent factors are biological influences whose impact on a population changes based on its size and density. Common examples include competition for resources, predation, and the spread of disease, all of which become more intense as the number of individuals increases. These factors act as natural regulators that help keep populations within the carrying capacity. By slowing growth as density rises, they contribute to stability.

69. (A) I, II, and III only
Predation and herbivory are fundamental interactions where one organism consumes another for energy. Allelopathy is a specialized form of competition where plants release chemicals to inhibit neighbors. While parasitism harms the host, it rarely causes immediate death. Furthermore, biological invasion typically involves non-native species rather than native ones. These diverse interactions drive the evolution of species and shape the overall structure of biological communities.

70. (B) Speciation
Biodiversity faces major threats from human activities, including habitat destruction, over-exploitation of resources, and pollution. These factors lead to population declines and species extinctions. Speciation, however, is a natural evolutionary process that creates new species, thereby increasing biological diversity over time. While the current rate of extinction far exceeds the rate of speciation due to environmental pressures, the formation of new species remains the primary mechanism.

71. (D) Genetic material preserved in artificial environments.
In vitro conservation involves preserving genetic material, such as seeds, pollen, or tissue samples, in a controlled laboratory environment. This technique is a specialized form of ex situ conservation that allows for long-term storage of genes under artificial conditions like cryopreservation. It provides a vital safety net for endangered species whose habitats are lost, ensuring that their unique genetic information remains available for future research.

72. (A) Scientific search for valuable genetic resources in nature.
Bio-prospecting is the systematic and scientific search for valuable genetic or biochemical resources in nature. This process aims to identify new compounds for use in medicine, agriculture, or industry. While it can lead to important discoveries, it must be conducted ethically to ensure that benefits are shared fairly. When done correctly, bio-prospecting supports both economic development and the ongoing conservation of biological diversity.

73. (C) Safety, comparing therapeutic dose to toxic dose.
The therapeutic index is a critical measurement in pharmacology and toxicology that compares the dose of a drug that produces a beneficial effect to the dose that causes toxicity. A higher index indicates a larger margin of safety, meaning the drug is less likely to cause harm at its effective dosage. Understanding this relationship is essential for ensuring that medications can be administered safely.

74. (A) Both A and R are true and R is the correct explanation of A.
In situ conservation is widely considered the most effective way to preserve biodiversity because it protects species within their natural ecosystems. By maintaining the entire habitat, this approach ensures that organisms can continue to interact with their environment and undergo natural evolutionary processes. This not only conserves the target species but also protects countless other life forms, providing a holistic and sustainable method for protection.

75. (A) Industrial Ecology
Industrial ecology is a field of study that views industrial manufacturing processes as part of an interconnected system, similar to natural ecosystems. The goal is to optimize the flow of materials and energy so that waste from one process serves as raw material for another. By modeling industrial systems on natural ecological cycles, this approach aims to reduce the environmental impact of human activities.

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used when a species' habitat is too degraded or threatened for survival in the wild. Methods include maintaining populations in zoological parks, botanical gardens, and seed banks. These facilities provide controlled environments where individuals can be bred, ensuring a genetic backup that can be used for future reintroduction.

43. (D) Sanctuary
A wildlife sanctuary is a designated protected area specifically intended for the conservation of fauna and flora. Unlike national parks, which have very strict regulations, sanctuaries may allow certain human activities, such as limited forestry or grazing, provided they do not significantly harm the wildlife. This flexible management approach helps balance the needs of local communities with the necessity of protecting biodiversity and maintaining health.

44. (B) In situ conservation protected by local communities.
Sacred groves are traditional patches of forest that are protected by local communities due to their religious or cultural significance. These areas serve as important examples of in situ conservation, as they preserve native biodiversity and rare species within their natural environment. By prohibiting activities like hunting or logging, these communities have historically maintained these mini-reservoirs of genetic diversity, contributing significantly to regional conservation.

45. (C) Gene pool
The gene pool represents the complete set of unique alleles found within a specific population or species. This genetic reservoir determines the potential for adaptation and evolution in response to changing environmental conditions. A large and diverse gene pool increases the likelihood that individuals will possess traits necessary for survival during biological challenges. Maintaining genetic diversity within the gene pool is therefore crucial for species viability.

46. (D) Biopiracy
Biopiracy involves the commercial exploitation of biological resources or traditional knowledge without the consent of or fair compensation to the indigenous communities that originated them. This practice often involves patenting naturally occurring genetic material or biochemicals for profit. It raises significant ethical and legal concerns regarding sovereign rights over biodiversity. Efforts like the Biological Diversity Act aim to prevent such exploitation by ensuring equitable benefit-sharing.

47. (C) Statement I is true, but Statement II is false.
Restoration ecology focuses on the scientific practice of renewing degraded or destroyed ecosystems to their natural state. The goal is to return the habitat to its original function and biodiversity rather than simply introducing commercially valuable species. By employing various techniques like reforestation and soil remediation, scientists aim to support the recovery of native communities. Successful restoration requires a deep understanding of ecological processes.

48. (B) Endangered
An endangered species is one that faces an exceptionally high risk of becoming extinct in the wild in the immediate future. This categorization is based on factors such as rapidly declining populations, habitat loss, or extreme specialization. Identifying species in this category is a critical step in conservation biology, as it triggers legal protections and targeted recovery efforts designed to stabilize populations and prevent permanent loss.

49. (B) Model industrial systems on natural ecological cycles.
Industrial ecology is a framework that aims to redesign industrial systems to function more like natural ecosystems. The core concept is to create closed-loop systems where the waste products of one process become the resources for another, similar to how nutrients cycle in nature. By minimizing waste and maximizing resource efficiency, industrial ecology seeks to reduce the environmental footprint of manufacturing and promote sustainability.

50. (A) Absorption
Absorption is the initial process by which a toxic substance crosses a biological barrier and enters the body's systems. This can occur through various routes, including the skin, lungs, or digestive tract. Once absorbed, the chemical can then be distributed throughout the body,

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In ecology, a community is defined as the assembly of all interacting populations of different species living within a specific geographic area. This includes plants, animals, fungi, and microorganisms that depend on each other for resources like food and space. Understanding community dynamics is essential for studying how species coexist and compete. The structure of a community is shaped by complex interactions and physical environment.

85. (C) Timber
Provisioning ecosystem services are the tangible products and raw materials that humans obtain from nature. Timber is a classic example, providing wood for construction, furniture, and fuel. Other provisioning services include food, fresh water, and medicinal plants. These benefits are essential for human survival and economic activity. Protecting the ecosystems that provide these resources is crucial for ensuring a steady supply of natural materials.

86. (C) II, IV, III, I
The distribution of terrestrial biomes follows a predictable pattern based on latitude, moving from the poles toward the equator. Starting at the highest latitudes, the tundra is followed by the taiga or boreal forest. As one moves further south into temperate regions, deciduous forests become dominant. Finally, the tropical rain forest is found at the lowest latitudes near the equator, reflecting the increase in temperature.

87. (D) Species in fragmented habitats with migration.
The concept of a metapopulation is vital for understanding species that live in fragmented habitats, where small, local populations are separated by unsuitable areas. These groups are connected by the occasional migration of individuals, which can help recolonize patches where a local population has gone extinct. This network approach provides an accurate view of species survival, highlighting how movement between fragments maintains genetic diversity.

88. (A) They have low species richness but high abundance.
Biodiversity hotspots are defined by having exceptionally high species richness and a large number of endemic species found nowhere else. They are also characterized by having lost a significant portion of their original habitat, making them urgent priorities for conservation. The statement that they have low species richness is incorrect, as high richness is a fundamental criterion. Protecting these areas is essential for biological heritage.

89. (C) Allelopathy
Allelopathy occurs when an organism releases chemical compounds into the environment that inhibit the growth or development of other species. In this case, the fungus produces a substance that prevents nearby seeds from germinating, reducing competition for resources. This chemical interaction is a common strategy used by plants and microorganisms. Understanding these processes is important for ecological research, agriculture, and managing the impact of invasive species.

90. (A) Species diversity indices (e.g., Shannon-Wiener)
Species diversity indices, such as the Shannon-Wiener index, are used to quantify the biodiversity of an area by considering both the number of different species present and their relative abundance. This provides a more comprehensive measure than simple species richness. By accounting for evenness, these indices help ecologists understand how well-balanced a community is and assess the overall health and stability of the ecosystem.

91. (B) P-2, Q-3, R-1, S-4
Conservation strategies are categorized by their location and methodology. In situ methods like biosphere reserves protect species in natural habitats, while community-led efforts like sacred groves rely on local traditions. Ex situ conservation maintains populations outside their native range. Specialized in vitro techniques like cryopreservation store genetic material in laboratory conditions. These diverse approaches work together to ensure the preservation of genetic diversity and species survival.

92. (B) Evolutionary Biology
Evolutionary biology is the branch of science that investigates the origins of life and the processes that lead to the diversification of species over time. This includes studying speciation, where

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76. (B) Extirpation
The term extirpation refers to the local disappearance of a species from a specific geographic area, even if it still exists elsewhere on earth. While often a precursor to global extinction, extirpation represents a significant loss of local biodiversity and can disrupt regional ecosystem functions. Understanding the causes of these local disappearances is vital for developing effective conservation strategies aimed at preventing complete disappearance.

77. (B) Biodiesel produced from vegetable oils.
Biofuels are fuels derived from contemporary biological materials, such as plant oils, animal fats, or agricultural waste. Biodiesel is a prominent example, produced through chemical processing of vegetable oils. These fuels offer a renewable alternative to traditional fossil fuels and can help reduce greenhouse gas emissions. Integrating biofuels is a key strategy for promoting environmental sustainability and reducing dependence on finite, polluting energy sources.

78. (A) Climax community
A climax community represents the final and most stable stage of ecological succession in a particular environment. In this phase, the species composition remains relatively constant over time because the community has reached an equilibrium with the local climate and soil conditions. This self-perpetuating system is characterized by complex food webs and efficient nutrient cycling. It will persist until a significant disturbance restarts the process.

79. (C) Ecotone - A sharp, impermeable barrier between two ecosystems.
Habitat and niche correctly describe an organism's physical location and functional role. Species diversity accurately refers to the variety and abundance of different organisms. However, defining an ecotone as an impermeable barrier is incorrect. An ecotone is actually a transitional zone where two ecosystems overlap and interact, often serving as a rich area of biodiversity. These zones are highly permeable, allowing for movement.

80. (D) Low temperatures and thin soil at high altitudes.
The Highland Icy Alpine Biome features sparse and low-growing vegetation primarily due to the harsh environmental conditions found at high altitudes. Extremely low temperatures and a very short growing season limit plant growth, while thin, nutrient-poor soils provide little support for larger trees. Additionally, high winds and intense solar radiation further challenge survival. These factors favor hardy, specialized plants like mosses and dwarf shrubs.

81. (B) I, II, and III only
A food web provides a realistic representation of the complex feeding relationships within an ecosystem by connecting multiple food chains. Unlike simple chains, webs show how organisms often occupy several trophic levels simultaneously. This interconnectedness enhances ecosystem stability by providing alternative energy pathways. While energy flows through the web, it is not cyclical but moves unidirectionally from producers to consumers, with energy lost as heat.

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82. (A) Establish safe human exposure from animal study data.
The margin of safety is a fundamental concept in toxicology used to establish safe levels of human exposure to chemicals based on data from animal studies. It represents the gap between the dose that causes no observed adverse effects in animals and the estimated dose humans might encounter. By incorporating uncertainty factors, scientists can ensure that regulatory limits are set low enough to protect people.

83. (C) Excavating contaminated soil and treating it in a bioreactor.
Ex situ remediation involves the removal of contaminated materials from their original location for treatment elsewhere. A common example is excavating polluted soil and processing it in a controlled bioreactor or specialized treatment facility. This approach allows for more precise control over environmental conditions like temperature and nutrient levels, which can accelerate degradation of toxins by microbes. It is useful for highly concentrated pollution.

84. (D) All interacting populations of species in a given area.

features support a specific community of plants and animals adapted to subarctic climate. The taiga plays a critical role in global carbon storage.

101. (C) The rapid growth of water hyacinth displacing native species.
Biological invasion occurs when a non-native species is introduced to a new environment and spreads rapidly, causing ecological harm. The case of water hyacinth is a classic example, as this plant can quickly cover water bodies, blocking sunlight and depleting oxygen levels. This displacement of native aquatic species disrupts the local food web and leads to biodiversity decline. Managing such invasive species is a major challenge.

102. (B) + / -
Herbivory is an ecological interaction where an animal, the herbivore, consumes a plant for nutrients and energy. This relationship is classified as a positive-negative interaction because the animal benefits from the food source while the plant is harmed by the loss of tissue. Like predation, herbivory is a key driver of energy transfer in food webs and influences the evolution of both plant defenses and animal feeding behaviors.

103. (D) Endangered, vulnerable, and rare species.
The term 'threatened species' is a broad conservation category used to identify organisms that are at risk of extinction. This classification includes species designated as endangered, which face an immediate threat, as well as vulnerable and rare species that are susceptible to decline. By grouping these species together, conservationists can highlight the overall level of risk and implement protective measures to stabilize populations.

104. (A) They are grown on excavated soil to absorb pollutants.
In ex situ bioremediation, plants are used to clean up contaminants by being grown on soil that has been excavated and moved to a controlled environment. This process, part of phytoremediation, allows for more efficient monitoring and optimization of the cleaning process. The plants absorb or stabilize pollutants, such as heavy metals, from the material. This technique provides a managed way to restore contaminated earth.

105. (C) An endemic species
An endemic species is one that is naturally found only in a specific, limited geographic area and nowhere else in the world. This restricted distribution makes such species particularly vulnerable to extinction if their habitat is destroyed or disturbed. Protecting these unique organisms is a high priority for conservation efforts, as their loss would mean the permanent disappearance of that species from the entire global gene pool.

106. (D) Lotic
Lotic ecosystems are aquatic environments characterized by flowing water, such as rivers, streams, and creeks. The constant movement of water influences the physical structure of the habitat, the levels of dissolved oxygen, and the types of organisms that can survive. Species in lotic systems often have specialized adaptations, like streamlined bodies or anchors, to prevent being swept away by the current. These systems are vital.

107. (A) Resources are patchy, or there is a social tendency to aggregate.
A clumped pattern of population dispersion occurs when individuals are grouped together in specific areas within their habitat. This pattern is often the result of resources, such as food or water, being distributed unevenly across the landscape. Additionally, social behaviors can lead to aggregation for protection or cooperative hunting. This is the most common type of dispersion in nature, reflecting interactions between organisms and environment.

108. (A) P-3, Q-4, R-1, S-2
Biotechnology and ecology use specific terms to describe interactions between organisms and the environment. Bioremediation involves using living things to clean up pollution, while bioindicators are species that reflect environmental quality. Biofuels are renewable energy sources derived from biological material. Biosensors are analytical devices that utilize biological components to detect chemical substances. Together, these concepts illustrate how biological principles can be applied to solve problems.

109. (C) Life history and reproductive strategies.

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The concept of 'r' and 'k' selection describes two different life history and reproductive strategies used by species to survive and reproduce. 'r-strategists' focus on rapid growth and producing many offspring in unpredictable environments, while 'k-strategists' emphasize competitive ability and long-term stability in crowded habitats. These classifications help ecologists understand how species respond to environmental pressures and how they allocate resources throughout their life cycles.

110. (D) Excretion
Excretion is the final process in toxicology where the body eliminates toxic substances or their metabolites through organs like the kidneys, lungs, or skin. This crucial mechanism prevents the accumulation of hazardous chemicals in tissues, thereby reducing the risk of long-term damage or chronic toxicity. The efficiency of excretion depends on the chemical properties of the substance and the health of the individual's biological systems.

111. (B) Presence of permafrost.
The chaparral biome is characterized by hot, dry summers and mild, rainy winters, supporting drought-resistant evergreen shrubs. Fire is a natural and frequent occurrence that helps maintain the ecosystem. However, the presence of permafrost is not a feature of this biome. Permafrost is a permanently frozen subsoil layer exclusively found in extremely cold regions. Chaparral environments are typically located in mediterranean climates where temperatures remain above freezing.

112. (A) 2002
The Indian Parliament passed the Biological Diversity Act in 2002 to fulfill its obligations under the international Convention on Biological Diversity. This legislation is crucial for regulating access to the country's biological resources and ensuring the fair sharing of benefits derived from their use. By establishing a legal framework to prevent biopiracy and protect traditional knowledge, the act supports long-term conservation and sustainable use of India's heritage.

113. (B) Bioaccumulate in the body.
When a toxicant is excreted very slowly, it remains in the body for an extended period, increasing the likelihood that it will bioaccumulate in tissues. This accumulation can lead to significant health problems over time, even if individual doses are small. Substances that are lipid-soluble are particularly prone to this process, as they are stored in fatty tissues and are difficult to eliminate. Understanding excretion is vital for assessing risks.

114. (B) I, III, and IV only
Human ecology explores the complex and bidirectional relationship between human societies and their natural environments. It acknowledges that human settlements significantly alter local ecosystems through activities like urbanization. This field is concerned with the design of sustainable communities and the ecological impact of human activity. Contrary to the idea of a one-way impact, human ecology emphasizes that environmental changes also affect human health, highlighting the need for coexistence.

115. (D) Airborne aerobe.
An airborne aerobe is a microorganism that travels through the air and requires oxygen for its metabolic processes and growth. These organisms are commonly found in atmospheric environments and play various roles, ranging from decomposers to pathogens. Understanding their presence is important for public health and air quality management. Unlike anaerobes, which thrive in environments without oxygen, aerobes are well-adapted to high-oxygen conditions found in the air.

116. (B) How communities change over time after a disturbance.
Ecological succession is the process by which the species composition of a biological community changes over time, following a disturbance or creation of a new habitat. It describes the predictable sequence of species, ending with a stable climax community. This concept helps scientists understand how ecosystems recover structure and biodiversity. By studying succession, ecologists can predict future changes in the environment and develop effective strategies for habitat restoration.

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117. (A) Both A and R are true and R is the correct explanation of A.
Ecosystems with complex food webs are generally more stable than those with simple food chains because they possess a high degree of functional redundancy. In a complex web, multiple species provide alternative energy pathways. If one species is lost due to environmental changes, other organisms can fill the gap, preventing a collapse of the entire system. This structural complexity provides a buffer against disturbances, ensuring ongoing flow of energy.

118. (A) Assist the recovery of an ecosystem that has been degraded, damaged, or destroyed.
The main objective of restoration ecology is to assist in the recovery of ecosystems that have been degraded or destroyed by human activities. This involves scientific interventions designed to return the habitat to its original ecological state, including its biodiversity and functional processes. Successful restoration projects aim to improve environmental quality and restore services like water filtration. It is a proactive approach to conservation that reverses past ecological damage.

119. (C) Slow development and long lifespan
Species known as 'k-strategists' are characterized by slow development, large body size, and a long lifespan. They typically thrive in stable environments where populations remain near the carrying capacity and competition for resources is high. These organisms invest significant energy into producing few high-quality offspring and providing extensive parental care to ensure survival. This strategy contrasts with 'r-strategists,' who produce many offspring quickly, highlighting different biological approaches to persistence.

120. (B) The dose that is lethal to 50% of a test population.
LD50, or the median lethal dose, is a standard measure used in toxicology to determine the acute toxicity of a substance. It refers to the specific dose that is lethal to 50% of a tested population of organisms under controlled conditions. This value allows scientists to compare the relative hazards of different chemicals and establish safety guidelines. A lower LD50 value indicates a more toxic substance, as a smaller amount is fatal.

121. (B) Self-replicating molecules in abiotic environments.
The scientific hypothesis for the origin of life suggests that it began approximately four billion years ago with the formation of self-replicating molecules in abiotic environments. These simple structures gradually evolved into more complex systems, eventually leading to the first cells. This fundamental concept in environmental biology helps explain how all living things are connected. Understanding these early processes is essential for exploring the origins of biodiversity and principles of biology.

122. (A) Urban
Natural ecosystems are primarily categorized by their physical environment and dominant life forms, such as deserts and oceans. These systems function through natural processes with minimal human influence. Urban environments, while supporting some biological communities, are classified as artificial or human-made ecosystems. They are defined by high population density and significant intervention in energy flows. Distinguishing between systems is crucial for understanding how human activities alter global ecological balance and biodiversity.

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123. (C) Each trophic level passes on approximately 10% of its energy to the next level.
The '10% rule' in ecology states that only about ten percent of the energy available at one trophic level is successfully transferred to the next higher level. The remaining ninety percent is lost to the environment, primarily as heat through metabolic processes, or remains as undigested organic matter. This significant energy loss limits the total number of trophic levels an ecosystem can support and explains why large predators are less abundant.

124. (B) I, IV, and V only
In situ conservation focuses on protecting species within their natural habitats, allowing for preservation of entire ecosystems. Examples include national parks and wildlife sanctuaries, which are officially designated areas managed for conservation. Sacred groves also represent in situ conservation, as they are traditionally protected

A species is designated as 'Extinct in the Wild' when it no longer exists in its natural habitat and is only found in human-managed environments, such as botanical gardens or zoos. This status indicates a critical level of risk, where the species depends entirely on human intervention for survival. While these individuals maintain the genetic lineage, the loss of the species from its ecological niche represents a significant decline in habitat biodiversity.

141. (A) I and II only
Biodiversity conservation involves two main approaches: in situ and ex situ. In situ conservation protects species within their natural habitats, while ex situ conservation preserves species outside their native environments, such as in seed banks. National parks are primary tools for in situ protection, while seed banks are specialized ex situ facilities. Both strategies are essential for a comprehensive conservation plan, providing both natural habitat preservation and a secure backup of diversity.

142. (B) Phytoremediation
Phytoremediation is a specific type of bioremediation that utilizes various plant species to remove, stabilize, or destroy environmental contaminants in soil and water. Plants can absorb heavy metals through their roots, break down organic pollutants, or prevent the spread of toxins in the ground. This eco-friendly and cost-effective technology is increasingly used to restore degraded sites while improving the local landscape. Understanding the specific mechanisms by which plants process pollutants is key.

143. (C) Dominated by grasses, forbs, and shrubs, often used for grazing.
Rangeland ecosystems are large areas of land characterized by a dominance of native grasses, forbs, and shrubs rather than dense forests. These regions are primarily used for grazing by domestic livestock and wild herbivores. Rangelands provide essential ecosystem services, including forage production, water regulation, and carbon sequestration. They are often managed through sustainable grazing practices to maintain biodiversity. Protecting these open landscapes is vital for supporting rural livelihoods and specialized plant communities.

144. (D) The spatial pattern of individuals within a population.
In population ecology, dispersion refers to the spatial pattern of individuals within a specific geographic area. It describes how organisms are arranged relative to one another, which can be clumped, uniform, or random. This characteristic is influenced by environmental factors like resource distribution and social interactions. By studying dispersion patterns, ecologists can gain valuable insights into species behavior and the underlying environmental conditions that shape their distribution across a particular habitat or ecosystem.

145. (B) Habitat fragmentation
Habitat fragmentation occurs when a large, continuous ecosystem is broken into smaller, isolated patches, often due to human activities like road building. This process creates significant challenges for biodiversity, as small fragments may not support large populations. Fragmentation also increases the amount of edge area, which can alter environmental conditions and facilitate the entry of invasive species. Maintaining habitat connectivity is essential for the long-term survival of many native species in modern landscapes.

146. (A) Nutrient cycling
Cultural ecosystem services include the non-material benefits that people obtain from nature, such as spiritual enrichment, aesthetic enjoyment, and recreational opportunities like ecotourism. These services contribute significantly to human well-being. Nutrient cycling, however, is a supporting service that provides the fundamental biological and chemical processes necessary for an ecosystem to function. While vital for life, it is a functional process rather than a direct cultural benefit provided to human societies by the environment.

147. (C) Biome
A biome is a large-scale ecological area defined primarily by its characteristic climate, soil types, and dominant forms of vegetation. Unlike a specific population or community, biomes encompass vast regions of the earth and represent unique combinations of biological and physical features. Common examples include deserts and tropical rainforests. By classifying the world

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significant problems, some can become invasive, outcompeting native organisms and disrupting local ecosystems. Understanding introduction pathways is vital for preventing biological invasions. These non-native organisms can significantly alter the biodiversity and ecological functions of the habitats they inhabit, posing conservation challenges.

133. (C) Industrial Ecology
Industrial ecology is based on the principle that industrial systems should be designed to mimic the efficient material and energy flows of natural ecosystems. The goal is to create a circular economy where waste from one process becomes a valuable resource for another, minimizing the consumption of raw materials and environmental pollution. By integrating biological concepts into industrial design, this field seeks to achieve a more sustainable balance between growth and preservation.

134. (D) Cryopreservation of seeds and embryos.
In vitro conservation is a specialized ex situ strategy that involves the preservation of genetic material under controlled laboratory conditions. Cryopreservation, the storage of seeds, embryos, or tissues at extremely low temperatures, is a primary example of this technique. By keeping biological samples in an artificial state of suspended animation, scientists can protect the genetic diversity of endangered species for long periods. This provides a critical backup for species at risk.

135. (C) III, I, II, IV
Hydrarch succession describes the process of community change that occurs in a body of water, eventually leading to a terrestrial climax community. It begins with the phytoplankton stage, followed by the appearance of submerged plants. As the water body fills with sediment, the reed-swamp stage develops, characterized by emergent vegetation. Finally, the area transitions into a stable climax forest. This sequence illustrates how aquatic ecosystems can naturally transform into diverse terrestrial habitats.

136. (B) Soil formation.
Supporting ecosystem services are fundamental processes that are necessary for the production of all other ecosystem services. Soil formation is a primary example, as it provides the essential foundation for plant growth and nutrient cycling. Other supporting services include primary production and water cycling. These underlying functions maintain the health and integrity of the entire ecosystem. Protecting these functions is critical for sustaining global biodiversity and human well-being across the planet.

137. (C) The seasonal increase and decrease in the number of insects.
A population fluctuation refers to the natural variations in the number of individuals within a population over time. A classic example is the seasonal increase and decrease in insect populations, which often peak during warm periods and decline in cold or dry seasons. These changes are driven by environmental factors like temperature and food availability. Monitoring these fluctuations is important for understanding population dynamics and predicting response to broader environmental changes.

138. (A) Both Statement I and Statement II are true.
The therapeutic index is a standard measure used in pharmacology to assess the safety of a drug. It is calculated by taking the ratio of the dose that causes toxic effects to the dose that provides a therapeutic benefit. A large therapeutic index indicates that there is a wide range between an effective dose and a harmful one, making the medication relatively safe for use. This information is vital for determining appropriate dosages.

139. (A) Both A and R are true and R is the correct explanation of A.
Mangrove ecosystems are correctly classified as estuarine because they thrive in the specialized brackish water environment where freshwater from rivers meets the saltwater of the sea. These tidal forests have developed unique adaptations to survive in saturated, saline soils. By functioning as a buffer between land and ocean, mangroves protect coastlines from erosion and provide essential nursery habitats for marine species, highlighting their vital role in maintaining coastal biodiversity and ecosystem health.

140. (D) The species survives only in cultivation or captivity.

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is fundamental to ecology, as they maintain the necessary balance required to sustain all life.

171. (C) Biosensor
A biosensor is a specialized analytical device that uses a biological component to detect the presence of a specific chemical substance and produce a measurable signal. In this scenario, a scientist creating a device that glows when it encounters a pollutant is developing a type of biosensor. These tools are valuable for environmental monitoring because they provide a rapid and specific way to identify contaminants in air or water, offering a practical solution for ecological assessment.

172. (D) Mega-diversity country
India is classified as a mega-diversity country because it possesses an extraordinary variety of life forms and ecosystems, including regions like the Western Ghats and the Himalayas. This designation is given to a small number of nations that together contain a significant majority of the world's species. India's rich biodiversity is supported by its diverse climate and geography. Protecting this immense biological heritage is vital for ensuring ongoing provision of essential ecosystem services and maintaining biodiversity.

173. (B) Their reproductive strategy and environmental response.
The fundamental difference between 'r' and 'k' species lies in their reproductive strategies and how they respond to environmental conditions. 'r-strategists' are adapted to unpredictable habitats, emphasizing rapid growth and production of many offspring with minimal care. In contrast, 'k-strategists' thrive in stable environments where populations remain near carrying capacity, focusing on fewer, high-quality offspring and providing extensive care. These distinct patterns allow different species to survive in a wide variety of ecological niches.

174. (A) In situ conservation - Seed bank
In situ conservation involves protecting species within their natural habitats, such as in national parks. A seed bank, however, is an ex situ conservation method because it involves preserving biological material in a controlled laboratory environment outside of its native ecosystem. The other pairs are correctly matched: hotspots are defined by high endemism, keystone species have a disproportionate impact on their communities, and allelopathy refers to chemical inhibition, reflecting important concepts in modern ecological science.

175. (C) Mangrove (Estuarine)
Mangrove ecosystems are characterized by salt-tolerant, or halophytic, vegetation found in the intertidal zones of tropical and subtropical coastlines. These areas function as essential buffer zones, protecting inland regions from storm surges and erosion. They thrive in brackish water conditions where rivers meet the sea. By providing a rich nursery habitat for many marine species and supporting a unique community of life, mangroves play a critical role in maintaining the health of coastal environments.

176. (B) The number of individuals in its population.
An ecological niche encompasses the complete functional role of a species within its ecosystem, including its habitat, resources used, and interactions with other organisms. It also describes environmental conditions, such as temperature and humidity, that the species can tolerate. However, the total number of individuals in a population is a demographic characteristic rather than a component of the species' niche itself. Understanding the niche helps ecologists explain how different species coexist and share resources within communities.

177. (A) Both A and R are true and R is the correct explanation of A.
Speciation is the fundamental evolutionary process that results in the formation of new and distinct species from existing populations. This process is a primary driver of biological diversity, as it increases the total number of species globally. By developing unique genetic traits and becoming reproductively isolated, these new species can occupy different ecological niches. Therefore, understanding speciation is essential for explaining the vast variety of life and the ongoing evolution of biological systems through history.

178. (A) Toxicology and Microbiology
The study of major water-borne diseases and air-borne microbes is a key component of both toxicology and microbiology. These fields investigate how various biological agents

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into biomes, scientists can better understand global distribution of biodiversity and the broad environmental factors that shape natural systems.

148. (D) Extinction
Extinction is the complete and permanent disappearance of a species from the entire planet. It occurs when the last living individual of that species dies, resulting in a permanent loss of genetic diversity and a unique evolutionary lineage. While extinction is a natural process, the current rate of species loss is significantly accelerated by human activities such as habitat destruction. Protecting endangered species is a primary goal of conservation biology to prevent irreversible losses.

149. (B) Occupational health and toxicology.
The concept of Threshold Limit Value (TLV) is a critical standard used in occupational health and toxicology to define safe levels of chemical exposure for workers. It represents the maximum concentration of a substance in the air that can be inhaled daily over a working lifetime without causing adverse health effects. Establishing these values is essential for creating safe industrial environments and protecting employees from chronic illnesses related to the inhalation of hazardous gases.

150. (D) I, II, III, IV, and V
Global biodiversity is currently facing a crisis driven by several interconnected major threats. Habitat loss and fragmentation reduce available space, while over-exploitation depletes populations. Additionally, the introduction of invasive species, environmental pollution, and the accelerating impacts of climate change all contribute to declining biodiversity. Together, these factors disrupt ecosystem functions and lead to species extinctions. Addressing these challenges requires a comprehensive and multi-faceted approach to environmental protection and sustainable resource management globally.

151. (C) The Western Ghats
The Western Ghats is a mountain range in India that is globally recognized as one of the world's primary biodiversity hotspots. This region is home to an extraordinary number of endemic species, including plants, birds, and amphibians found nowhere else. However, it also faces significant threats from habitat loss. Protecting the Western Ghats is essential for preserving India's unique biological heritage and maintaining the vital ecosystem services that the region provides to millions.

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152. (D) Mutualism
The interaction between a bee and a flower is a classic example of mutualism, where both species receive a benefit from the relationship. The bee obtains energy-rich nectar for food, while the flower is successfully pollinated as the bee moves between blooms. This co-evolutionary partnership is vital for the reproduction of many flowering plants and the survival of diverse insect populations. Mutualistic interactions like this are fundamental to the structure and productivity of ecosystems.

153. (B) Food web
A food web is a graphical representation that illustrates the complex network of feeding relationships among species within an ecosystem. Unlike a simple food chain, which shows a single path of energy, a web demonstrates how energy flows through multiple interconnected pathways as organisms consume various types of prey. This model provides an accurate view of how biological communities are structured and how the loss of one species can impact the stability of the system.

154. (B) P-4, Q-1, R-2, S-3
Species are classified based on their conservation status and ecological impact. Endangered species face a very high risk of extinction, while extinct species have no known living individuals. Keystone species play a vital role, exerting a disproportionately large influence relative to abundance. Invasive species are non-native organisms that cause harm when introduced. Understanding these categories is essential for developing effective strategies to protect biodiversity and manage healthy environments globally in various habitats.

155. (D) Biotransformation
Biotransformation is a critical physiological process where the body chemically alters a toxic substance through metabolic reactions, primarily occurring in the liver. The main goal is usually to convert lipid-soluble toxins into water-soluble

forms that can be more easily excreted. While this often detoxifies the chemical, in some cases, it can produce intermediate metabolites that are more harmful. This metabolic process is a key component of the body's defense against foreign and hazardous agents.

156. (A) Energy
In an ecosystem, nutrients like carbon and water are continuously recycled between living organisms and the physical environment through biogeochemical cycles. However, energy follows a different path, entering the system primarily as sunlight and flowing unidirectionally through trophic levels. At each step, a significant amount of energy is lost as heat and cannot be reused by producers. Therefore, while matter is conserved, energy must be constantly replenished by an external source.

157. (C) Tundra
The Highland Icy Alpine Biome is the high-altitude equivalent of the Arctic tundra. Both environments are characterized by extremely low temperatures, sparse vegetation, and the absence of trees. At high elevations, the conditions mimic those found at high latitudes, including thin soils and short growing seasons. Because they share many similarities, these regions support similar types of specialized life forms, such as mosses and hardy perennial plants adapted to extreme cold and windy conditions.

158. (B) They have a long life span.
Species known as 'r-strategists' are adapted to exploit unpredictable environments through rapid growth and reproduction. They typically have small body sizes and produce many offspring with minimal parental care. However, they are characterized by having short life spans rather than long ones. This strategy allows them to quickly establish populations before the environment changes or competition becomes too intense. Their biological focus is on maximizing the rate of increase rather than long-term individual survival.

159. (D) The absence of species like stoneflies and mayflies.
Certain aquatic organisms, such as stoneflies and mayflies, are highly sensitive to pollution and low oxygen levels. Their absence from a stream or river where they are expected to occur serves as a clear bio-indicator of poor water quality. By monitoring the presence of these sensitive species, scientists can assess the health of an ecosystem without relying solely on chemical tests. This biological approach provides a long-term view of environmental conditions and aquatic health.

160. (A) To serve as a repository for plant genetic material for long-term conservation.
The primary goal of a seed bank is to serve as a secure repository for plant genetic material to ensure long-term conservation. These facilities store seeds under controlled conditions to preserve viability for decades or centuries. This provides a vital backup against loss in the wild due to habitat destruction or climate change. By maintaining diverse genes, seed banks support future agricultural research, reforestation efforts, and the restoration of various degraded natural ecosystems.

161. (D) A is false but R is true.
Exponential growth describes a population increasing without limits, a situation that only occurs in environments with unlimited resources. In such cases, there is no upper limit, so the concept of carrying capacity does not apply. Carrying capacity is actually a central feature of the logistic growth model, where growth slows down as the population reaches the maximum size that the environment can sustainably support. Therefore, carrying capacity represents the limit imposed by environmental resistance.

162. (A) Biodiversity
Biodiversity refers to the immense variety of life found across all levels of biological organization, including genetic, species, and ecosystem diversity. It encompasses millions of different organisms, their complex interactions, and the diverse habitats they inhabit. This variety is essential for maintaining ecosystem health, productivity, and resilience against environmental changes. Protecting biodiversity is a fundamental goal of conservation science, as it ensures the ongoing provision of essential services that support all life on earth.

163. (C) Treating contamination at its original location.

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In situ bioremediation is a specialized process that uses living organisms to degrade or neutralize environmental pollutants directly at the site of contamination. This approach avoids the need to excavate and transport materials, making it cost-effective and less disruptive. Microbes or plants are used to metabolize harmful chemicals into non-toxic substances. This technique is widely applied to treat groundwater pollution and contaminated land, helping to restore ecological health to damaged areas naturally and efficiently.

164. (C) Deciduous Forest Biome
The deciduous forest biome is characterized by trees that shed their leaves annually in response to seasonal changes. These forests are typically found in regions with moderate rainfall and distinct warm and cold seasons. As the fallen leaves decompose, they create fertile, nutrient-rich soils that support a diverse understory of plants and a wide variety of animal life. This biome's structure and productivity are closely tied to the seasonal cycle of leaf growth and loss.

165. (C) Toxicology (specifically, toxicokinetics)
Toxicokinetics is a specialized area within toxicology that focuses on the study of how toxic agents move through a living organism. It examines the processes of absorption into the body, distribution to various tissues, the metabolic changes of biotransformation, and the eventual excretion of the substance. Understanding these pathways is essential for predicting potential impact and determining safe exposure levels. This scientific approach provides quantitative data needed to assess risk and manage hazardous substances effectively.

166. (B) Niche diversity
Biodiversity is traditionally categorized into three fundamental levels: genetic diversity, species diversity, and ecosystem diversity. Genetic diversity is the variation within species, while species diversity is the variety of different organisms. Ecosystem diversity involves the range of habitats and processes. While the concept of an ecological niche is vital for understanding how species interact within a community, 'niche diversity' is not recognized as a separate, primary level of biodiversity in standard biological frameworks.

167. (A) I, III, IV, II
India's environmental protection efforts have evolved through several legislative milestones. The Wildlife (Protection) Act of 1972 provided the first major legal framework for safeguarding fauna and flora. This was followed by the launch of Project Tiger in 1973. The Environment (Protection) Act was enacted in 1986 for broader environmental management. Finally, the Biological Diversity Act was passed in 2002 to regulate access to resources and prevent biopiracy, reflecting modern conservation priorities and international obligations.

168. (A) Extinction of native species.
A primary and severe consequence of biological invasion is the potential extinction of native species. When non-native organisms are introduced, they often lack natural predators and can rapidly outcompete local species for essential resources like food and nesting sites. This intense competition, along with the introduction of new diseases or significant habitat alteration, can lead to the decline and eventual disappearance of native populations. Protecting ecosystems from such invasions is critical for maintaining global biodiversity.

169. (C) Commensalism (+/0)
Commensalism is a type of ecological interaction where one species benefits while the other is neither helped nor harmed. A classic example is an orchid growing on the branch of a tree. The orchid benefits by gaining better access to sunlight high in the canopy, which is essential for its growth. The tree, however, remains unaffected as the orchid does not take nutrients or water from its tissues. This interaction highlights complex ways species coexist.

170. (D) They describe the movement of chemical elements through the Earth's spheres.
Biogeochemical cycles correctly describe the continuous movement and transformation of chemical elements through the biological, geological, and chemical components of the earth's spheres. These cycles involve both living organisms and non-living parts of the environment. Unlike the unidirectional flow of energy, these processes ensure that essential nutrients like carbon and nitrogen are recycled within the biosphere. Understanding these cycles

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forest patches maintained by local communities. In contrast, botanical gardens and gene banks are ex situ methods, as they involve maintaining biological material in controlled, artificial settings.

125. (C) Competition
Competition is an ecological interaction where species strive for the same limited resources, such as food or territory. Because the presence of each competitor reduces the availability of resources for others, both parties are negatively impacted. This relationship drives natural selection, favoring individuals with traits that allow more efficient resource use. Consequently, competition shapes community structure and biodiversity, influencing how various organisms coexist and share finite environmental assets in a habitat.

126. (B) To enhance the nutrient availability to plants through the activity of microorganisms.
The primary role of a biofertilizer is to improve soil fertility and plant growth by increasing the availability of essential nutrients through the activity of microorganisms. These products contain living bacteria, fungi, or algae that fix atmospheric nitrogen or solubilize minerals. By enhancing the nutrient uptake of plants naturally, biofertilizers provide a sustainable alternative to chemical fertilizers, helping to maintain soil health and reduce pollution in modern agricultural systems.

127. (D) Tropical Rain Forest
Tropical rain forests have the highest net primary productivity per unit area of any terrestrial biome. This is due to the combination of year-round warm temperatures, high humidity, and abundant rainfall, which provide ideal conditions for continuous plant growth. The dense vegetation captures large amounts of solar energy and converts it into biomass efficiently. High productivity in these regions supports extraordinary levels of biodiversity and plays a critical role in cycles.

128. (A) Areas with high species richness and high levels of threat.
The identification of biodiversity hotspots is a conservation strategy that prioritizes regions characterized by exceptionally high species richness and a significant number of endemic organisms. To qualify as a hotspot, an area must also have lost at least seventy percent of its original natural habitat. By focusing efforts on these vulnerable regions, conservationists aim to protect the maximum amount of unique biological diversity with limited resources, preventing permanent loss.

129. (B) The environment is uniform, and there are no strong social interactions.
A random pattern of population dispersion occurs when the position of each individual is independent of others in the area. This typically happens in environments where resources are distributed uniformly and there are no strong social attractions between organisms. Because individuals do not specifically seek out or avoid each other, their arrangement appears haphazard. While less common than clumped dispersion, random patterns provide insight into the lack of intense competitive pressures.

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130. (A) Ability to grow on bare rock or mineral soil.
Pioneer species are the first organisms to colonize a new or disturbed habitat during the process of primary succession. A key characteristic is their ability to grow on bare rock or mineral soil, where few other species can survive. These hardy organisms, such as lichens and mosses, begin the process of soil formation by breaking down rocks and adding organic matter, eventually allowing more complex plant communities to establish.

131. (A) P-4, Q-1, R-2, S-3
Toxicology tracks the movement and change of chemicals within the body through several distinct processes. Absorption is the initial entry of a substance, while distribution involves its movement through the bloodstream to various organs. Biotransformation refers to the metabolic alteration of the chemical, often to make it more water-soluble for easier removal. Finally, excretion is the process of eliminating the substance or its metabolites from the body. Together, these determine toxicity.

132. (B) An exotic or alien species
An exotic or alien species is one that has been introduced, either intentionally or accidentally, to a region where it does not naturally occur. While many such species do not cause

and chemical toxins enter and affect living organisms through environmental pathways. By understanding mechanisms of infection and the impact of hazardous substances, scientists can develop better strategies for public health and environmental protection. This research is essential for preventing the spread of disease and ensuring the safety of air resources.

179. (C) Wildlife Sanctuary
A wildlife sanctuary is a designated protected area where the primary goal is the conservation of specific fauna and their habitat. Unlike national parks, sanctuaries often allow certain human activities, such as collection of minor forest products or limited grazing, provided these actions do not adversely affect wildlife. This flexible management approach allows for a balance between ecological preservation and the traditional livelihoods of local communities, helping to maintain a sustainable relationship with the natural environment.

180. (D) The effect of environmental resistance and K.
The logistic growth model differs from the exponential model by incorporating the effects of environmental resistance and the carrying capacity of the environment. While the exponential model assumes unlimited resources and constant growth, the logistic model recognizes that as a population increases, resources become limited and growth slows down. This results in an S-shaped curve that stabilizes at the carrying capacity, reflecting a realistic view of population dynamics in natural systems where essential resources are finite.

181. (A) P-3, Q-1, R-4, S-2
Ecological interactions between species are often described using symbolic representations of their impact. Mutualism is a positive-positive relationship where both species benefit. Predation is a positive-negative interaction where the predator gains and the prey loses. Commensalism is a positive-neutral relationship where one species benefits and the other is unaffected. Competition is a negative-negative interaction because both parties are harmed by the struggle for limited resources. These symbols provide a simple way to categorize diverse relationships.

182. (A) A small population, which is not currently 'Endangered' or 'Vulnerable', but is at risk.
Rare species are characterized by having small populations that are often thinly scattered across a wide area or confined to very specific, limited habitats. While they may not be currently designated as endangered or vulnerable, their low numbers and restricted distribution make them susceptible to environmental changes. Monitoring these species is a vital part of conservation efforts, as identifying their unique requirements can help prevent them from declining further and ensure their genetic contribution to biodiversity.

183. (C) It integrates principles from multiple scientific fields.
Ecology is fundamentally an interdisciplinary science that integrates principles from various fields, including biology, chemistry, physics, and geology. By combining these different scientific perspectives, ecologists can better understand the complex interactions between living organisms and their non-living environment. This holistic approach allows for a more comprehensive study of ecosystem functions, such as energy flow and nutrient cycling, and provides necessary tools to address modern environmental challenges like climate change and habitat loss today.

184. (B) Bioaccumulation
Bioaccumulation refers to the gradual buildup of a toxic chemical in the tissues of an individual organism over its entire lifetime. This occurs when the organism absorbs the substance faster than it can be metabolized or excreted. Substances that are persistent in the environment and lipid-soluble are particularly prone to bioaccumulating in the body's fat stores. Understanding this process is critical for assessing long-term health risks posed by pollutants and predicting how they might impact individual survival.

185. (B) Keystone species
The reintroduction of wolves to Yellowstone National Park is a classic case study that demonstrates the profound impact of a keystone species on an ecosystem. As top predators, wolves controlled elk populations, which allowed vegetation to recover and created habitats for many other species. This series of ecological changes, known as a trophic cascade,

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dioxide. Biosensors are valuable tools that convert biological interactions into measurable signals. Contrary to the fifth statement, the primary role of a biofertilizer is to enhance soil nutrient availability rather than acting as a pesticide, highlighting sustainable use.

201. (C) Extremely low temperatures and permafrost.
The tundra biome remains treeless primarily due to its extremely low temperatures and the presence of a permanently frozen layer of subsoil known as permafrost. This frozen ground prevents the development of deep root systems required by most trees. Furthermore, the short growing season and harsh, windy conditions favor low-growing vegetation such as mosses, lichens, and small shrubs. These specialized plants have adapted to thrive in a cold environment with limited water availability and nutrient-poor soil.

202. (B) Genetic diversity
The concept of a gene pool is most directly related to genetic diversity, which is the variety of different alleles and genes present within a specific population or species. A large and diverse gene pool provides the raw material for evolutionary adaptation, allowing species to respond to environmental challenges such as disease or climate change. Protecting this level of biodiversity is essential for the long-term viability of species, as it ensures they have resources necessary to survive.

203. (D) Energy is created by producers and destroyed by top consumers.
Ecosystem functions are governed by the laws of thermodynamics. While nutrients are cycled continuously between biotic and abiotic components, energy follows a unidirectional flow. It enters the system as sunlight and is captured by producers, then passes through consumers and decomposers. Crucially, energy is neither created nor destroyed but is transformed from one form to another, with energy lost as heat at each trophic level. The statement that energy is created or destroyed is incorrect.

204. (A) P-3, Q-4, R-2, S-1
Different biomes are defined by their characteristic vegetation, which is determined by the local climate. Tropical rain forests are dominated by broadleaf evergreen trees, while hot deserts feature plants like cacti adapted to aridity. The tundra is characterized by low-growing mosses and dwarf shrubs that can survive extreme cold and permafrost. Taiga ecosystems are primarily composed of coniferous trees. These distinct plant communities highlight the diverse biological adaptations found across various global environments and climates.

205. (C) Bio-prospecting
Bio-prospecting is the scientific exploration of biodiversity to identify molecular, genetic, and biochemical resources that have potential commercial or medicinal value. This process aims to discover new compounds for developing pharmaceuticals or industrial materials. When conducted ethically, bio-prospecting can support both economic growth and the conservation of natural resources. It is distinguished from biopiracy, which involves unauthorized exploitation of resources without fair benefit-sharing with the communities of origin. Protecting this process ensures fair and sustainable development.

206. (B) Repeated exposure over a prolonged period.
Chronic toxicity refers to the adverse health effects that result from repeated or long-term exposure to a toxic substance over an extended period, often months or years. Unlike acute toxicity, which manifests immediately after a single high dose, the symptoms of chronic exposure develop slowly as damage accumulates in the body's tissues. Understanding chronic toxicity is vital for assessing risks of environmental pollutants, as it helps establish long-term safety limits to protect individuals from delayed health problems.

207. (D) Pollination
Pollination is a critical supporting ecosystem service that enables the reproduction of many flowering plants, including crops essential for human food production. While it directly supports provisioning services like food, it is fundamental to the overall functioning and productivity of the ecosystem. Other supporting services include nutrient cycling, soil formation, and primary production. These underlying biological processes maintain the health of the environment, ensuring the continued delivery of all benefits that nature provides to human societies and species.

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193. (B) The fair and equitable sharing of benefit from genetic resources.
Biopiracy is a significant ethical and legal issue related to the fair and equitable sharing of benefits derived from biological resources. It occurs when corporations or researchers exploit the biodiversity and traditional knowledge of a region without the consent of the original communities. This practice can lead to the unfair patenting of life forms. Modern international agreements and national laws aim to prevent biopiracy by ensuring that benefits are shared transparently with those who provided resources.

194. (A) Cryopreservation
Ex situ biodiversity conservation involves the protection of endangered species outside of their natural habitats. Cryopreservation is a specialized ex situ technique where genetic material, such as seeds or tissue samples, is stored at extremely low temperatures in a laboratory setting. This method provides a secure long-term backup for species whose native environments are under threat. In contrast, measures like biosphere reserves and national parks are in situ strategies that focus on protecting species within ecosystems.

195. (C) Land dominated by grasses rather than shrubs or trees.
The primary characteristic of the grassland biome is that it is dominated by various types of grasses rather than large trees or shrubs. These ecosystems are typically found in regions with moderate rainfall that is sufficient for grass growth but not enough to support a forest. Periodic fires and grazing by large herbivores are also critical factors that prevent the establishment of woody vegetation. Grasslands provide essential ecosystem services and support a diverse array of specialized wildlife.

196. (D) Biomagnification
Biomagnification is the process by which the concentration of a persistent toxic substance increases in the tissues of organisms at successively higher levels of a food chain. This occurs because top-level predators consume many individuals from lower trophic levels, each of which has already accumulated the toxin. As a result, the concentration reaches its highest point in top consumers. Understanding biomagnification is essential for assessing the long-term impact of pollutants like heavy metals and persistent pesticides.

197. (A) Typhoid
Typhoid fever is a serious water-borne disease caused by the bacterium Salmonella typhi. It is typically transmitted through the ingestion of water or food contaminated with the feces of an infected person. Preventing typhoid requires improved sanitation, access to clean drinking water, and effective hygiene practices. While other diseases like measles are viral and spread through different pathways, typhoid remains a significant public health concern in regions with inadequate water treatment systems and poor waste management.

198. (B) Structural changes at the boundary of two habitats.
The edge effect refers to the significant changes in species composition and environmental conditions that occur at the boundary between two different habitats. These transitional zones often exhibit higher biodiversity because they contain a mix of species from both adjacent ecosystems along with organisms specifically adapted to the edge environment. This phenomenon is a critical concept in conservation biology, especially in the context of fragmentation, as it can alter the internal dynamics of remaining habitat patches.

199. (C) Extinct, Rare, Endangered and Threatened.
Flora and fauna that are at risk of disappearing are categorized into several levels based on their population size and the degree of threat they face. These categories include extinct species, endangered species, and threatened or rare species. Using these standardized classifications helps conservationists prioritize their efforts and implement legal protections designed to stabilize populations and prevent the irreversible loss of biodiversity from various ecosystems across the globe. This scientific framework is essential for managing environmental health.

200. (C) I, II, III and IV only
Biological principles are applied in many environmental technologies. Azotobacter is a useful nitrogen-fixing biofertilizer, while ethanol produced from sugarcane is a significant biofuel. Lichens serve as excellent bioindicators for air quality because they are sensitive to sulfur

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highlights how the presence of a single species can significantly alter the structure and function of an entire community, emphasizing species protection.

186. (A) Aesthetic value
Cultural ecosystem services are the non-material benefits that humans derive from nature, contributing to their psychological, spiritual, and social well-being. Aesthetic value is a primary example, as many people find beauty and inspiration in natural landscapes, which can improve mental health. Other cultural services include spiritual significance and recreational opportunities. These benefits underscore the deep connection between human societies and the natural world, highlighting the importance of conserving ecosystems for their intrinsic and cultural worth.

187. (A) Both Statement I and Statement II are true.
A biome is correctly defined as a large-scale community of plants and animals that occupies a distinct geographic region characterized by a specific climate. The distribution of these biomes across the globe is primarily determined by environmental factors such as latitude, altitude, and average patterns of temperature and precipitation. By categorizing the biosphere into biomes, scientists can study the broad ecological patterns that govern biological communities and predict how they might shift in the future.

188. (B) Humans and their physical/biotic environments.
Human ecology is the study of the dynamic and bidirectional relationship between human populations and their physical and biotic environments. It investigates how societies adapt to their surroundings and how human activities fundamentally alter natural ecosystems. By combining insights from both social and environmental sciences, human ecology seeks to understand the sustainability of human settlements and the long-term impacts of human behavior on global biodiversity and the essential life-support systems that humans depend on.

189. (B) A sudden volcanic eruption
Density-dependent factors are biological influences that regulate populations based on their size, such as competition for food and the spread of disease. These factors become more intense as population density increases. In contrast, a sudden volcanic eruption is a density-independent factor. Its impact on the population is not related to how many individuals are present; the event will affect organisms regardless of their density. Such abiotic disturbances can cause sudden, dramatic shifts in population size without biological feedback.

190. (C) I, III and IV only
Ecosystem stability is generally enhanced by high biodiversity, which provides multiple pathways for energy flow. Resistance refers to an ecosystem's ability to withstand disturbances, while resilience is its capacity to recover quickly after a disruption. Contrary to the idea that simple systems are more stable, complex food webs are typically more robust because they possess functional redundancy. Understanding these properties is crucial for managing natural systems and predicting how they will respond to increasing environmental pressures.

191. (C) The movement of the water (flowing vs. standing).
The primary difference between lotic and lentic ecosystems lies in the movement of the water. Lotic systems are characterized by flowing water, such as rivers and streams, where the current is a dominant physical factor shaping the habitat. Lentic systems, in contrast, consist of standing or relatively still water, like lakes and ponds. This fundamental distinction influences every aspect of the ecosystem, from levels of dissolved oxygen to the specific adaptations of organisms that live there.

192. (D) Both A and R are false.
Industrial ecology does not promote a linear flow of materials; instead, it advocates for a circular system modeled on natural ecological cycles. The primary goal is to minimize waste generation and maximize resource efficiency by using the waste of one process as raw material for another. This approach seeks to decouple economic growth from environmental degradation. Therefore, both the assertion and the reason provided are incorrect representations of the fundamental principles of modern industrial ecology science.

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208. (A) Both A and R are true and R is the correct explanation of A.
Species classified as 'r-strategists' are often the first to colonize new habitats because of their unique biological traits. Their rapid growth rates, high fecundity, and excellent dispersal abilities allow them to quickly establish populations before competition from other species increases. These pioneer organisms are well-adapted to take advantage of temporary environments where resources are temporarily abundant. By investing in high reproductive output, they ensure the survival of their lineage in unpredictable landscapes, fulfilling a role.

209. (B) Metapopulation
A metapopulation consists of a network of semi-isolated local populations of the same species that are connected through the occasional movement or migration of individuals between them. This concept is especially important for species living in fragmented habitats, as the exchange of individuals can help prevent the extinction of small groups and maintain genetic diversity. Understanding metapopulation dynamics is essential for modern conservation planning, as it helps identify critical corridors and habitat patches necessary for species survival.

210. (A) To facilitate in situ conservation of biodiversity.
A primary objective of establishing protected areas like national parks and wildlife sanctuaries is to facilitate the in situ conservation of biodiversity. These areas provide a secure environment where species can thrive in natural habitats, interacting with their surroundings and continuing evolutionary processes. By protecting the entire ecosystem and its functions, these designated zones safeguard genetic diversity. This approach is fundamental to global efforts to maintain healthy biological communities and prevent species extinction in the wild environment.

211. (A) IV, I, III, II
Biological organization follows a hierarchical structure from the simplest to the most complex levels. It begins with the individual organism as the basic unit. A group of organisms of the same species living in an area forms a population. Different interacting populations in a given location make up a community. Finally, the community together with its non-living physical environment forms an ecosystem. Understanding these levels is essential for studying ecology, as it helps scientists analyze interactions and processes.

212. (D) Umbrella species
An umbrella species is one whose conservation requirements are so broad that protecting its habitat naturally confers protection to many other species within the same ecosystem. These organisms typically require large areas of high-quality habitat to survive. By focusing conservation efforts on an umbrella species, such as a large carnivore, scientists can efficiently preserve a wide range of biodiversity and maintain the integrity of the overall landscape. This strategic approach helps maximize the effectiveness of limited conservation resources.

213. (C) A pharmaceutical drug
The therapeutic index is a critical ratio used in medicine and pharmacology to assess the relative safety of a pharmaceutical drug. It is calculated by comparing the dose of the medication that produces the desired therapeutic effect with the dose that causes toxic or harmful reactions. A high therapeutic index indicates a greater margin of safety, meaning the drug is less likely to cause harm at its effective dosage. Determining this value is essential for ensuring treatments safe use.

214. (B) Bacteria
In an ecosystem, the environment is divided into abiotic and biotic components. Abiotic factors are the non-living physical and chemical elements, such as sunlight and temperature, which provide the framework for life. Biotic components include all living organisms, such as plants, animals, and bacteria. While bacteria are microscopic, they are biological entities that interact with other organisms and participate in processes like decomposition and nutrient cycling. Therefore, bacteria are correctly classified as a biotic part of the biological community.

215. (B) I, II and III only
Bioremediation is the scientific process of using living organisms to break down or neutralize environmental contaminants. In situ methods treat the pollution at its original site, while ex

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situ techniques involve removing the material for treatment elsewhere. These strategies are effective for organic pollutants and can also be used to stabilize or extract heavy metals, though the mechanisms differ. Together, these approaches provide flexible and eco-friendly solutions for environmental cleanup, helping to restore health to damaged soil and water.

216. (B) The logistic model of population growth.
Carrying capacity is a central concept in the logistic model of population growth, representing the maximum number of individuals of a species that an environment can sustainably support. This limit is determined by the availability of essential resources like food and space. As a population grows and approaches this capacity, environmental resistance increases, causing the growth rate to slow and stabilize. Understanding this relationship is vital for ecological research, as it helps predict how populations fluctuate and respond to environmental changes.

217. (B) Tundra
Permafrost, a layer of soil that remains permanently frozen throughout the year, is a defining characteristic of the tundra biome. This frozen ground restricts the growth of deep-rooted plants, leading to a landscape dominated by mosses, lichens, and small shrubs. Located in the high latitudes, the tundra experiences extremely cold temperatures and short growing seasons. The presence of permafrost significantly influences the hydrology and ecological structure of this biome, creating a unique and fragile environment for specialized life.

218. (A) The competitive exclusion principle
The competitive exclusion principle states that two species competing for the exact same limited resources cannot coexist indefinitely in the same ecological niche. Eventually, the more efficient species will outcompete the other, leading to its local extinction or an evolutionary shift to a different niche. This fundamental concept in ecology explains how resource partitioning and niche diversification allow multiple species to survive within the same community. It highlights the importance of specialization in maintaining biodiversity and complex biological systems.

219. (C) Pumping nutrients into the ground to stimulate naturally occurring microbes.
In situ bioremediation involves treating contaminated materials at their original location without moving them. A common example is pumping nutrients or oxygen into the ground to stimulate the growth and activity of naturally occurring microbes that can degrade pollutants in the soil. This approach is often more cost-effective and less disruptive than traditional cleanup methods. By enhancing natural biological processes, in situ bioremediation provides a sustainable way to restore environmental health to sites damaged by industrial activities or spills.

220. (B) P-3, Q-4, R-1, S-2
Protected areas are managed for different levels of conservation and human use. National parks provide a high degree of protection for wildlife and their habitats. Sanctuaries are designated for the protection of specific fauna, though some human activities may be allowed. Biosphere reserves focus on conservation of overall biodiversity and sustainable resource use within different zones. Sacred groves represent traditional, community-based protection of forest patches. Together, these strategies form a comprehensive network for preserving global biological diversity and ecosystems.

221. (D) Tropical Rain Forest and Desert
The savanna biome serves as a vast transitional ecosystem between the lush tropical rain forests and the arid hot deserts. It is characterized by high temperatures and a distinct seasonality in rainfall, featuring an open landscape of grasses with scattered trees. This biome represents a middle ground where moisture levels are high enough to prevent desertification but insufficient to support the growth of a continuous forest canopy. Periodic fires and grazing help maintain this balance, supporting a unique biological community.

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222. (C) Thinly scattered over a wider area or in specific limited areas.
Rare fauna are species that have small population sizes and are thinly scattered over a large geographic range or restricted to very specific and limited habitats. While they may not be in immediate danger of extinction like endangered species, their low numbers and

specific requirements make them vulnerable to environmental changes. Protecting these organisms is essential for maintaining biodiversity. Monitoring rare species helps conservationists understand the specialized niches they occupy and implement measures to prevent their decline toward critical status.

223. (B) The safe level of worker exposure over a working lifetime.
In toxicology and occupational health, the Threshold Limit Value (TLV) represents the maximum concentration of a chemical in the air to which a worker can be exposed daily for a standard working lifetime without experiencing adverse effects. These values are established through rigorous scientific research and are used to set safety standards in industrial environments. By maintaining chemical levels below the TLV, companies can protect their employees from toxicity, ensuring a safe and healthy workplace for long-term productivity.

224. (A) Influenza virus
The influenza virus is a primary example of an airborne microbe, as it is transmitted through tiny droplets released into the air when an infected person coughs. Once airborne, the virus can be inhaled by others, leading to infection. Understanding the transmission pathways of such microbes is vital for public health management and preventing the spread of contagious diseases. In contrast, organisms like Vibrio cholerae are typically water-borne, illustrating different ways biological agents move through the environment to affect health.

225. (B) I, III, IV, and V only
Biodiversity is currently under threat from several major factors driven by human activity. Habitat destruction reduces living space for countless species, while over-exploitation of natural resources depletes populations. Environmental pollutants contaminate ecosystems, and biological invasions by non-native species disrupt local balances. While genetic diversity is a component of biodiversity, it is not a threat but rather a quality to be protected. Together, these negative influences lead to population declines and species extinctions, highlighting the need for conservation strategies.

226. (B) Ecosystem
The ecosystem is recognized as the fundamental functional unit of ecology because it encompasses both the living community of organisms and their non-living physical environment. Within an ecosystem, biotic and abiotic components interact to facilitate the flow of energy and the cycling of nutrients. By studying ecosystems, scientists can analyze the complex processes that sustain life and understand how natural systems respond to disturbances. This level of organization provides a holistic framework for exploring the diverse web of life.

227. (C) Two populations are separated by a geographical barrier.
Allopatric speciation is the most common form of speciation, occurring when two populations of the same species become geographically separated from each other. Barriers such as mountains or rivers prevent the exchange of genes between the groups. Over long periods, each population accumulates unique genetic differences due to natural selection in their separate environments. Eventually, the groups become so distinct they can no longer interbreed, resulting in the formation of two new and separate species with unique genetic lineages.

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228. (B) Both Statement I and Statement II are false.
The provided definitions for bio-prospecting and biopiracy are incorrect. Bio-prospecting is actually the legal and systematic exploration of biological resources for products of economic value, emphasizing sustainable use. Biopiracy involves the illegal appropriation of these resources without the consent of the original source. These concepts are fundamental to understanding the ethical frameworks governing the use of biodiversity. Correctly distinguishing between them is vital for promoting fair and equitable resource management and protecting the rights of communities worldwide.

229. (B) A land area for grazing livestock and wildlife.
The key feature of a rangeland ecosystem is its role as a land area primarily used for the grazing of domestic livestock and wild herbivores. These open landscapes are dominated by native grasses and shrubs that provide a sustainable food source for grazing animals. Rangelands also support a diverse array of wildlife and

provide essential services like water regulation. Proper management of these systems through sustainable grazing practices is necessary to maintain soil health, prevent erosion, and preserve biodiversity.

230. (D) Biogeochemical cycle
A biogeochemical cycle is the process by which organic and inorganic matter is moved and transformed through the biological, geological, and chemical components of an ecosystem. These cycles, involving elements like carbon and nitrogen, ensure that essential nutrients are recycled between living organisms and the physical environment. By returning materials back into the production of living matter, these pathways maintain the necessary chemical balance required for life. Understanding these cycles is fundamental to ecology and global environmental health.

231. (C) A species with high impact relative to its abundance.
A keystone species is defined by having an exceptionally high impact on the structure and function of its ecological community relative to its actual population size. Despite often being low in abundance, the presence of such a species is critical for maintaining biodiversity and preventing any single organism from dominating the environment. By influencing resource availability or regulating other populations, keystone species ensure the overall stability of the ecosystem. Their loss can lead to dramatic shifts in the community.

232. (B) Ethanol
Biofuels are renewable energy sources derived from contemporary biological materials, such as plants or agricultural waste. Ethanol, produced through the fermentation of sugars found in crops like sugarcane or corn, is a prominent example of a biofuel used primarily in transportation. These fuels offer a more sustainable alternative to fossil fuels, as they can help reduce greenhouse gas emissions. Integrating biofuels into the energy mix is a key strategy for promoting environmental sustainability and a circular economic system.

233. (C) The Tundra biome, but found at high altitudes.
The Highland Icy Alpine Biome is characterized by conditions that are very similar to the Arctic tundra, but it is found at high altitudes on mountains rather than at high latitudes. Both environments experience extremely cold temperatures, thin soils, and a lack of trees. They support specialized communities of low-growing plants like mosses adapted to the harsh, windy conditions. Because of these shared characteristics, these high-altitude regions represent a mountain version of the cold arctic landscapes.

234. (A) Both A and R are true and R is the correct explanation of A.
The use of biofertilizers is widely promoted as a sustainable agricultural practice because they enhance soil fertility naturally. These products contain beneficial microorganisms that can fix atmospheric nitrogen or make minerals like phosphorus more available to plants. By improving nutrient uptake through biological processes, biofertilizers reduce the need for chemical fertilizers, which can cause environmental pollution. This approach supports long-term soil health, increases crop yields, and promotes an environmentally friendly method of farming for future food production.

235. (D) Ex situ conservation
Ex situ conservation is the practice of protecting components of biological diversity outside of their natural habitats. This approach is necessary when a species' native environment is so threatened that its survival in the wild is at risk. Common methods include maintaining populations in botanical gardens, zoological parks, and seed banks. These controlled environments provide a secure backup of genetic diversity that can be used for future reintroduction efforts. Ex situ conservation is a vital complement to habitat protection.

236. (A) All populations of different species interacting in a given area.
In ecology, a community is defined as the assembly of all interacting populations of different species that live within a specific geographic area. This includes all plants, animals, fungi, and microorganisms that share the same habitat and depend on each other for resources. Understanding the structure and dynamics of a

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community is essential for studying how species coexist, compete, and facilitate each other's survival. The diversity of these interactions is fundamental to overall ecosystem health and function.

237. (C) It is unidirectional and decreases at each successive trophic level.
Energy flow in an ecosystem is correctly described as a unidirectional process where energy enters as sunlight and moves through various trophic levels. Unlike nutrients, which are recycled, energy is lost to the environment as heat at each successive transfer from producers to consumers. This loss occurs because of metabolic processes and the second law of thermodynamics. Consequently, the amount of available energy decreases at higher trophic levels, limiting the total number of organisms they can support.

238. (B) I, II, III, and IV only
Biodiversity hotspots are priority areas for conservation identified by high species richness and endemism, along with significant habitat loss. The concept, introduced by Norman Myers, helps target regions like the Indo-Burma area for urgent protection. These designations are based on biological criteria rather than economic value. By focusing efforts on these vulnerable regions, conservationists aim to prevent the loss of unique species found nowhere else. Protecting hotspots is a critical strategy for maintaining the global variety of life.

239. (D) The formation of new species, thus increasing species diversity.
Speciation is the fundamental evolutionary process that results in the formation of new and distinct species from existing ones. This process increases biological diversity by adding to the total number of unique life forms on earth. As populations evolve and become reproductively isolated, they can adapt to different ecological niches and environmental conditions. Over geological time scales, speciation has produced the vast variety of life found in different ecosystems. Understanding this process is essential for explaining biodiversity origins.

240. (B) A river and the sea.
An estuarine ecosystem is a specialized transitional zone located where freshwater from a river meets and mixes with the saltwater of the sea. This unique environment is characterized by brackish water, where salinity levels fluctuate with the tides and the amount of river discharge. Estuaries are highly productive systems that provide vital nursery habitats for many marine and bird species. They also play a critical role in filtering pollutants and protecting coastal areas from natural shore erosion.

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241. (B) They release essential nutrients from dead organic matter back into the ecosystem.
Decomposers play a vital role in biogeochemical cycles by breaking down dead organic matter and waste products. Through this process, they release essential nutrients back into the ecosystem in inorganic forms that can be reused by primary producers. Without decomposers, vital elements like carbon and nitrogen would remain trapped in dead tissues, eventually halting the entire cycle of life. By recycling these materials, decomposers ensure the ongoing productivity and health of natural environments worldwide for all species.

242. (A) Photosynthesis
Community interactions are the biological relationships between different species living in the same area, such as predation, parasitism, and various forms of symbiosis. These interactions shape the structure and diversity of the community. Photosynthesis, however, is a fundamental physiological process within an individual organism, primarily plants and algae, to convert solar energy into chemical energy. While it provides the foundation for energy flow, it is an internal metabolic function rather than an interactive relationship between different biological species.

243. (C) Restoring degraded ecosystems to a more natural state.
Restoration ecology is the scientific study and practice of renewing and restoring degraded, damaged, or destroyed ecosystems through active human intervention. The goal is to return these habitats to a natural and functional state, recovering their original biodiversity and ecological processes. This can involve reforestation, soil remediation, and the reintroduction of native species. By reversing the negative impacts of human activities, restoration ecology seeks to improve environmental quality

and restore the essential services healthy systems provide.

244. (D) The potential for invasive species to outcompete and displace native species.
The main threat posed by biological invasions is the potential for non-native species to rapidly outcompete and displace native species within an ecosystem. Because invasive organisms often lack natural predators, they can reproduce quickly and monopolize essential resources like food and space. This disruption can lead to a significant decline in local biodiversity and fundamentally alter the structure and function of the community. Protecting native ecosystems from these invasions is a top priority for preserving unique biological heritage.

245. (A) P-4, Q-1, R-3, S-2
Biotechnology and ecology utilize diverse organisms for specific roles. Rhizobium bacteria are vital biofertilizers that fix nitrogen, while lichens are excellent bioindicators for air quality. Certain fungi, like Penicillium, serve as sources for antibiotics, and yeast is used in the production of biofuels like ethanol. These examples illustrate how biological principles can be harnessed to address environmental challenges and develop important products. Understanding these relationships is essential for applying biotechnology sustainably to monitor and protect the natural world.

246. (B) Human Ecology
Human ecology is the scientific study of human populations and their complex, bidirectional relationship with the natural environment. It examines how societies adapt to different ecosystems and how human activities, such as urbanization and resource extraction, alter biological systems. By integrating insights from sociology and environmental science, human ecology aims to understand the sustainability of human settlements and the long-term impact of our actions on global biodiversity. This field provides a critical framework for achieving a sustainable coexistence.

247. (D) Tropical Rain Forest
The tropical rain forest biome is characterized by having the greatest diversity of species among all terrestrial ecosystems. This extraordinary biodiversity is supported by year-round warm temperatures, high humidity, and abundant rainfall, which provide ideal conditions for continuous plant growth and complex biological interactions. These forests are home to millions of different plants and animals, many found nowhere else. Protecting these regions is vital for preserving unique genetic heritage and maintaining ecosystem services that regulate global climate.

248. (A) Toxicokinetics
Toxicokinetics is the scientific field that examines the collective processes of absorption, distribution, metabolism, and excretion of toxic agents in living organisms. By studying how these chemicals move through and are changed by the body, researchers can predict the overall impact of a toxin and determine safe exposure limits. This information is fundamental for assessing environmental risks and developing medical treatments. Understanding toxicokinetics provides quantitative data necessary to manage hazardous substances effectively and protect public health from toxic effects.

249. (C) Biosphere Reserves
Biosphere reserves provide the broadest level of protection by conserving entire ecosystems and large-scale landscapes. These areas are designed to protect biodiversity while also promoting sustainable development through a zoning system. By integrating the needs of local communities with conservation goals, biosphere reserves preserve the genetic diversity of many species and maintain essential ecological processes. This holistic approach is more comprehensive than species-specific strategies, making it fundamental for large-scale environmental protection and long-term global sustainability.

250. (D) Functional role or profession in the ecosystem.
An organism's ecological niche is best described as its functional role or 'profession' within its ecosystem. It encompasses all the ways the species interacts with its environment, including the resources it consumes, the habitat it occupies, and its relationships with other species, such as predators or prey. Unlike a habitat, which is simply a physical location, the niche represents the complete set of conditions and interactions

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necessary for the species to survive and reproduce in nature.

251. (B) Energy flow is a unidirectional process, whereas biogeochemical cycling involves the movement of elements between biotic and abiotic components.
Energy flow in ecosystems follows a unidirectional path, starting with solar energy captured by producers and moving through trophic levels. In contrast, biogeochemical cycling involves the continuous movement and transformation of essential elements like carbon and nitrogen between living organisms and their non-living environment. This fundamental difference distinguishes the one-way transfer of energy from the circular recycling of nutrients.

252. (A) The gradual and predictable change in species composition over time.
Ecological succession represents the natural process of gradual and predictable change in the species composition of a given area over time. This dynamic process can occur on previously lifeless substrates or follow disturbances in established communities. It illustrates the transition from colonizing species to more complex biological assemblages, ultimately shaping the functional structure and long-term development of diverse ecosystems.

253. (C) The salinity level of the water in an estuary.
Ecosystems consist of biotic and abiotic components that interact to form a functional unit. Abiotic factors are the non-living chemical and physical parts of the environment that affect living organisms. Measuring the concentration of dissolved salts in a body of water identifies a critical physical parameter that influences the survival and distribution of various aquatic species within their specific habitats.

254. (D) A significant loss of energy between successive trophic levels.
Energy flow models are essential tools for illustrating how solar energy is transferred through different trophic levels in an ecosystem. These models highlight a significant and progressive loss of energy at each successive stage of the food chain. This reduction occurs because energy is dissipated as heat during metabolic processes, limiting the total biomass that higher levels can support.

255. (C) To capture solar energy and convert it into a usable form for the ecosystem.
Producers occupy the foundational level of the biotic structure within an ecosystem. Their primary role involves capturing solar energy through the process of photosynthesis and converting it into chemical energy. This conversion creates a usable form of energy that sustains all other life forms, including consumers and decomposers, thereby initiating the vital flow of energy through complex biological food webs.

256. (B) A habitat is the physical place where an organism lives, while a niche encompasses its functional role and interactions.
An ecological habitat identifies the specific physical location where an organism resides, determined by its environmental conditions. Conversely, an ecological niche is a broader concept that describes the functional role an organism plays within its community. This includes its interactions with other species, use of resources, and overall contribution to the energy flow and nutrient cycling of the ecosystem.

257. (D) The transition zone between two distinct biological communities.
The edge effect describes a phenomenon where transition zones between two distinct biological communities, known as ecotones, host a higher variety of life. These areas often demonstrate a greater density and diversity of species compared to the adjacent habitats. This increased biological activity occurs because the ecotone combines resources and environmental conditions from both neighboring ecosystems, supporting specialized and diverse organisms.

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258. (A) The level of species diversity within the community.
Species diversity serves as a fundamental indicator of the variety of life within a biological community. High levels of diversity significantly enhance ecosystem stability, allowing the system to resist environmental disturbances more effectively. Diverse communities are generally more resilient, possessing a greater capacity to recover quickly from changes because multiple species can fulfill similar functional

to extinction if their habitat is disturbed. The presence of a high number of endemic species is a key requirement for identifying regions as global biodiversity hotspots for conservation.

276. (A) Ex situ conservation.
Ex situ conservation involves the protection of biological diversity outside its natural habitat. Establishing seed banks to preserve the genetic material of various plants is a primary example of this off-site strategy. This method provides a safety net for rare or endangered species, ensuring their genetic information remains available for research, restoration, or reintroduction if their populations in the wild are severely depleted.

277. (D) A traditional, community-based approach to in situ conservation.
Sacred groves represent a traditional and community-based approach to in situ conservation found in many parts of India. These are patches of forest or natural vegetation dedicated to local deities and protected by local communities through religious beliefs and cultural practices. By preserving these areas in their natural state, sacred groves help maintain local biodiversity, ecosystem functions, and indigenous knowledge within their original environment.

278. (B) Conserving species within their natural ecosystems and habitats.
The fundamental principle of in situ conservation is the protection and management of species within their natural habitats and ecosystems. This strategy focuses on preserving the entire biological community and the complex interactions between different organisms and their environment. By maintaining species in their original surroundings, in situ conservation supports ongoing evolutionary processes and ensures the long-term sustainability of diverse ecological systems and services.

279. (C) Sanctuaries allow for more human activities compared to the stricter regulations in National Parks.
In India, both National Parks and Sanctuaries are forms of in situ conservation, but they differ in their regulatory levels. National Parks are strictly designated for the protection of wildlife and the environment, featuring highly restricted human activities. Sanctuaries, while also protected, are often species-oriented and may permit certain human activities, such as limited resource collection, provided they do not harm the wildlife.

280. (D) The preservation of biological tissues or cells in an artificial environment.
In vitro conservation is a specialized, high-tech form of ex situ preservation used for biological materials. This technique involves storing cells, tissues, or embryos in an artificial, controlled environment, often under cryogenic conditions. It is particularly useful for species that are difficult to conserve through traditional seed banks or captive breeding, providing a way to safeguard genetic diversity at the cellular level for future use.

281. (A) A corporation patents a chemical compound derived from a traditional medicinal herb without acknowledging or compensating the local community that has used it for generations.
Biopiracy refers to the unethical and often illegal appropriation of indigenous knowledge and genetic resources without proper authorization or fair compensation. A clear example is when a corporation patents a compound derived from a traditional medicinal plant used by local communities for generations without acknowledging their contribution. This practice exploits the biodiversity and cultural heritage of source countries for commercial gain without returning benefits.

282. (B) Assist the recovery of damaged or degraded ecosystems.
Restoration ecology is an applied scientific discipline focused on assisting the recovery of ecosystems that have been degraded, damaged, or destroyed. The primary goal is to return these habitats to a healthy, self-sustaining state by re-establishing original ecological processes and reintroducing native species. This work helps rebuild biodiversity and restores essential ecosystem services that were lost due to human activities or environmental disturbances.

283. (B) Bio-prospecting involves ethical and authorized exploration with benefit-sharing, whereas biopiracy is unauthorized exploitation.
Bio-prospecting and biopiracy both involve the search for valuable biological resources, but they differ fundamentally in ethics and legality.

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Biological invasion occurs when a non-native species is introduced to a new ecosystem and begins to proliferate rapidly. This phenomenon is considered highly disruptive because these invasive species often lack natural predators and can outcompete indigenous organisms for resources. Consequently, they cause significant harm to native biodiversity and upset the established ecological balance, leading to the degradation of local habitats and communities.

268. (A) The predator typically kills its prey, while the parasite usually does not kill its host immediately.
Predation and parasitism are distinct types of interactions involving a consumer and its target. In predation, the predator kills and consumes the prey for energy. In contrast, parasitism is a symbiotic relationship where the parasite benefits by living on or inside a host. Unlike predators, parasites typically do not kill their host immediately, as they rely on the living organism for continued nourishment.

269. (C) Predation.
Herbivory is categorized as a specific type of predation where an organism consumes plants or algae. While general predation often involves animals hunting other animals, the fundamental ecological process is similar: one organism benefits by consuming another living entity for energy. This interaction plays a vital role in shaping plant populations and influences the transfer of energy through various levels of a food web.

270. (D) An assemblage of interacting populations of different species in a given area.
In the study of ecology, a community is defined as an assemblage of interacting populations of different species inhabiting the same geographic area at the same time. This concept focuses on the complex web of relationships, such as competition, predation, and mutualism, that exist between various organisms. Understanding community structure is essential for analyzing how different species coexist and maintain the functional integrity of ecosystems.

271. (C) High percentage of endemic species and significant habitat loss.
The identification of a biodiversity hotspot relies on two specific and strict criteria to prioritize global conservation efforts. A region must contain a high percentage of endemic plant species, which are found nowhere else on Earth. Additionally, the area must have experienced a significant loss of its original habitat. These regions represent critical reservoirs of unique life that are under immediate threat of destruction.

272. (B) Genetic diversity.
Genetic diversity refers to the total variety of unique alleles or genetic information contained within the individuals of a single species. This type of biodiversity is evident in variations among different breeds of domesticated animals or varieties of crops. High genetic diversity is essential for the long-term survival and adaptation of a population, allowing it to respond to environmental changes and disease outbreaks.

273. (D) It prioritizes them for conservation efforts due to their unique and threatened biodiversity.
Identifying regions such as the Western Ghats and the Eastern Himalayas as biodiversity hotspots highlights their global significance and vulnerability. These areas are recognized for harboring unique assemblages of flora and fauna that are found nowhere else. Designating them as hotspots ensures that conservation resources and efforts are prioritized to protect these highly threatened ecosystems from further degradation and potential species extinctions.

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274. (A) The creation of national parks.
Biodiversity faces constant pressure from various human activities that degrade natural systems. Major threats include habitat loss, pollution, climate change, and the overexploitation of resources. Conversely, the creation of protected areas like national parks serves as a primary strategy for conserving biological diversity. These designated zones help safeguard species and their environments by restricting harmful activities and maintaining critical ecological processes and habitats.

275. (C) A species that is found exclusively in one specific geographic area.
Endemic species are organisms that are found exclusively within one specific geographic location, such as a particular island, mountain range, or country. Because their distribution is so restricted, these species are often more vulnerable

them to break down and detoxify contaminants directly in the soil or groundwater, providing a less disruptive cleaning strategy.

292. (A) In situ treats contaminants on-site, while ex situ involves moving the contaminated material for treatment.
Bioremediation strategies are primarily classified by the location of the treatment process. In situ methods address contaminants at their original site, minimizing disruption to the environment and reducing transportation costs. Conversely, ex situ bioremediation requires the removal of contaminated soil or water to a different location for treatment. This allows for more controlled conditions but often involves higher costs and significant physical site disturbance.

293. (D) Phytoremediation.
Phytoremediation is a specialized type of in situ bioremediation that utilizes various plant species to clean up contaminated environments. These plants can absorb, accumulate, and sometimes even break down pollutants like heavy metals or organic chemicals from soil and water. This biological approach offers a sustainable and cost-effective alternative to traditional engineering methods, using the natural physiological processes of plants to restore environmental health.

294. (B) Less disruptive to the site and generally more cost-effective.
In situ bioremediation is often the preferred choice for environmental cleanup due to its practical advantages. Because the treatment occurs on-site, there is no need for the expensive and labor-intensive process of excavating and transporting large volumes of contaminated material. This makes the process significantly less disruptive to the local ecosystem and generally more cost-effective compared to ex situ treatment methods in most scenarios.

295. (C) Living organisms to degrade or detoxify contaminants.
Bioremediation is defined as the application of biological processes to remediate contaminated environments. This field centers on using living organisms, primarily specialized microorganisms and plants, to degrade, transform, or detoxify hazardous pollutants into less harmful substances. By leveraging the natural metabolic capabilities of these biological agents, bioremediation provides an eco-friendly and sustainable way to clean up oil spills, heavy metals, and industrial waste.

296. (D) An organism whose condition reflects the health of its environment.
A bioindicator is an organism, species, or biological community whose presence, absence, or overall condition serves as a reliable measure of environmental health and quality. These biological markers respond to changes in their surroundings, such as levels of pollution or habitat degradation. By monitoring these organisms, scientists can assess the impact of human activities and environmental stressors on the integrity and sustainability of ecosystems.

297. (A) A biological component and a physicochemical detector.
A biosensor is an innovative analytical device that integrates a biological component with a physicochemical detector. The biological part, such as an enzyme, antibody, or nucleic acid, interacts specifically with a target substance. This interaction is then converted into a measurable signal by the detector. Biosensors are widely used for the rapid and precise detection of pollutants, pathogens, and various medical biomarkers in different samples.

298. (B) To promote plant growth by increasing nutrient availability through microbial action.
Biofertilizers are substances containing living microorganisms that promote plant growth by enhancing the supply and availability of essential nutrients. When applied to seeds or soil, these beneficial microbes colonize the rhizosphere and convert nutrients like nitrogen and phosphorus into forms that plants can easily absorb. This provides a sustainable and eco-friendly alternative to synthetic chemical fertilizers, improving soil health and agricultural productivity.

299. (B) Living matter such as crops or algae.
Biofuels represent a renewable energy source derived directly from recently living biological matter. Common sources include agricultural crops like corn and sugarcane, as well as specialized organisms like algae. These fuels offer a potential way to reduce greenhouse gas emissions and dependence on fossil fuels.

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Bio-prospecting is a legitimate, authorized process that involves systematic exploration with equitable benefit-sharing between researchers and source communities. Conversely, biopiracy involves the unauthorized exploitation and patenting of genetic resources and traditional knowledge, failing to provide any compensation or recognition to the original owners.

284. (A) The complete set of genetic information within a population or species.
The gene pool consists of the complete set of unique alleles and genetic information found within a specific population or species. Maintaining a large and diverse gene pool is vital for the health and survival of a species, as it provides the raw material necessary for adaptation to changing environmental conditions. Reduced genetic diversity within a gene pool can lead to increased vulnerability to diseases.

285. (C) The systematic search for valuable products from nature.
Bio-prospecting is described as the systematic and scientific search for valuable chemicals, genes, microorganisms, and other products from nature. This practice aims to discover new biological resources that can be used to develop innovative medicines, agricultural products, or industrial technologies. Ideally, bio-prospecting is conducted through formal agreements that ensure the benefits derived from these natural discoveries are shared fairly with the host communities.

286. (D) Biotransformation.
Biotransformation is a metabolic process through which an organism's body chemically modifies a toxic agent. This process typically occurs in the liver and aims to convert harmful substances into more water-soluble and less toxic forms, making them easier for the body to excrete. It is a critical defense mechanism that helps protect living organisms from the adverse effects of various environmental and chemical pollutants.

287. (C) Acute toxicity.
Toxicology distinguishes between different types of exposure and their resulting health effects. Acute toxicity refers to the adverse effects that occur shortly after a single, high-level exposure to a toxic substance. This is contrasted with chronic toxicity, which results from repeated or long-term exposure to lower concentrations of a pollutant. Rapid onset of symptoms following a chemical spill exemplifies the manifestation of acute toxic effects.

288. (B) Occupational exposure to airborne substances in a workplace.
The threshold limit value serves as a regulatory benchmark in occupational health and safety. It defines the concentration of a chemical substance in the air to which it is believed nearly all workers can be exposed daily throughout their careers without experiencing adverse health effects. This value is essential for establishing safe working conditions and monitoring air quality in industrial and laboratory environments.

289. (D) Measure the effects of a substance on living organisms.
A bioassay is a scientific procedure used to measure the potency or effects of a biological or chemical substance by observing its impact on living organisms. In toxicology, bioassays are fundamental for determining how toxic a substance is and identifying its potential hazards. These tests provide essential data for establishing regulatory safety standards, such as dosage limits for drugs and exposure thresholds for pollutants.

290. (A) A higher therapeutic index suggests a greater margin of safety between effective and toxic doses.
The therapeutic index is a crucial ratio used in pharmacology to evaluate the relative safety of a drug. It compares the dose that produces toxic effects to the dose that provides the desired clinical response. A higher therapeutic index indicates a wider margin of safety, meaning there is a significant difference between an effective dose and one that could cause harm to the patient.

291. (C) Nutrients are pumped into a contaminated aquifer to stimulate native bacteria to degrade a pollutant.
In situ bioremediation involves treating contaminated materials exactly where they are located without excavation or removal. A practical application of this method is the introduction of oxygen or nutrients into a polluted underground aquifer. These additives stimulate the metabolic activity of native microorganisms, encouraging

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(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

18. What is the process of breaking down rocks, soils, and minerals through contact with the Earth's atmosphere, water, and biological organisms?
(A) Weathering
(B) Deposition
(C) Transportation
(D) Lithification

19. Consider the following statements regarding soil formation:
1. Climate is a key factor influencing the rate and type of soil formation.
2. The parent material (rock) has no influence on the final soil properties.
3. Topography affects soil development through its influence on drainage and erosion.
4. Biological activity, including plants and microorganisms, contributes to soil formation.
5. Time is a crucial factor, as soil formation is a very slow process.

Which of the above statement(s) is/are correct?
(A) 1, 2, 3 and 4
(B) 1, 3, 4 and 5
(C) 2, 3, 4 and 5
(D) 1, 2, 4 and 5

20. Which of the following is a primary soil forming mineral that weathers to form clay minerals?
(A) Quartz
(B) Calcite
(C) Gypsum
(D) Feldspar

21. Match the items in List I with those in List II and select the correct option.
List I (Soil Property):
P. Cation Exchange Capacity (CEC)
Q. Soil Texture
R. Soil Structure
S. Soil Horizon
List II (Description):
1. The arrangement of soil particles into aggregates
2. A measure of the soil's ability to hold positively charged ions
3. A layer in the soil profile with distinct characteristics
4. The relative proportion of sand, silt, and clay
(A) P-1, Q-3, R-4, S-2
(B) P-2, Q-4, R-1, S-3
(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-4, R-2, S-1

22. The physical removal and transport of weathered material by agents such as water, wind, ice, or gravity is known as:
(A) Deposition
(B) Erosion
(C) Compaction
(D) Weathering

23. Read the following statements and select the correct option.
Statement I : The chemical composition of soil is independent of the climate in which it forms.
Statement II : The process of soil formation is a rapid phenomenon that can be observed over a few years.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

24. Which type of weathering involves the reaction of water with minerals to form new minerals?
(A) Hydrolysis
(B) Frost wedging
(C) Abrasion
(D) Exfoliation

25. Consider the following statements about soil properties:
1. Soil physical properties include texture, structure, and porosity.
2. Soil chemical properties include pH and cation exchange capacity.
3. Dark-colored soils are always more fertile than light-colored soils.
4. Climate control on soil formation means tropical soils are identical to polar soils.

Which of the above statement(s) is/are correct?

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However, their production involves complex considerations regarding land use, food security, and the overall environmental impact of intensive farming.

300. (A) A bioindicator.
Monitoring the health and presence of lichen communities on trees is a classic example of using a bioindicator to assess environmental quality. Lichens are particularly sensitive to air pollutants like sulfur dioxide, and their decline or disappearance can signal deteriorating air quality in a specific region. This biological approach provides a cost-effective and integrated method for long-term monitoring of the impacts of pollution.

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CHAPTER 04

Environmental Geosciences

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1. Which of the following best defines the primary geochemical differentiation of the Earth?
(A) The generation of Earth's magnetic field through core dynamics.
(B) Sorting of elements by density to form the core, mantle, and crust.
(C) Tectonic formation of continents and global ocean basins.
(D) Surface weathering of rocks through chemical degradation.

2. Read the following statements and select the correct option.
Statement I : The Coriolis force is an inertial force that acts on objects in motion within a frame of reference that is rotating.
Statement II : The Coriolis force is responsible for the initial movement of air from high to low pressure.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

3. Identify the incorrect pair regarding the layers of the Earth and their primary composition.
(A) Core - Primarily Iron and Nickel
(B) Mantle - Silicate rocks rich in Magnesium and Iron
(C) Crust - Composed mainly of liquid magma
(D) Hydrosphere - Total mass of free water on Earth

4. Which force is primarily responsible for initiating the movement of air, creating wind?
(A) Coriolis force
(B) Frictional force
(C) Gravitational force
(D) Pressure gradient force

5. Match the items in List I with those in List II and select the correct option.
List I (Geological Concept):
P. Primary geochemical differentiation
Q. Plate tectonics
R. Earth's energy budget
S. Steady state
List II (Description):
1. Balance between incoming and outgoing radiation
2. A condition where system properties are constant over time
3. Segregation of Earth into core, mantle, and crust
4. Theory explaining large-scale motion of the lithosphere
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

6. Which of the following is NOT a direct control on the formation of landforms?
(A) Plate tectonics
(B) The Earth's magnetic field
(C) Climatic conditions
(D) Volcanic activity

7. The formation of igneous rocks is a result of:
(A) Alteration of pre-existing rocks by intense heat and pressure.
(B) Compaction and cementation of varied accumulated sediments.
(C) Chemical precipitation of minerals from a saturated solution.
(D) The cooling and solidification of molten magma or lava.

8. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The geostrophic wind flows parallel to the isobars.
Reason (R) : The geostrophic wind represents a balance between the pressure gradient force and the Coriolis force.
(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

9. What is the concept of 'residence time' in the context of natural cycles?
(A) The time required for a resource to be fully depleted.
(B) The determined geological age of a rock formation.
(C) The average duration a substance spends in a reservoir.
(D) The duration of a complete cycle of seasonal change.

10. Consider the following statements about the Earth's layers:
1. The crust is the outermost solid layer of the Earth.
2. The mantle is located between the crust and the core.
3. The outer core is solid, while the inner core is liquid.
4. The core is primarily composed of silicate minerals.

Which of the above statement(s) is/are correct?
(A) 1 and $_2$ only
(B) 1, 2 and 3
(C) 3 and 4 only
(D) 1, 2, 3 and 4

11. Metamorphic rocks are formed through the transformation of existing rock types. What are the primary agents of metamorphism?
(A) Weathering, erosion, and deposition
(B) Cooling, solidification, and crystallization
(C) Compaction, cementation, and lithification
(D) Heat, pressure, and chemically active fluids

12. The Indian monsoon is a large-scale seasonal wind reversal. Which of the following is the most appropriate cause for this phenomenon?
(A) The gravitational pull of the moon.
(B) The differential heating and cooling of land and sea.
(C) The onset of El Nino and La Nina events.
(D) The rotation of the Earth on its axis.

13. What term describes a condition in a system where the inputs and outputs are balanced, leading to no net change over time?
(A) Equilibrium
(B) Catastrophe
(C) Differentiation
(D) Steady state

14. Consider the following stages of Earth's formation:
1. Formation of the atmosphere and hydrosphere.
2. Accretion of the proto-Earth from the solar nebula.
3. Primary geochemical differentiation into core, mantle, and crust.
4. Cooling and solidification of the crust.

Which of the following represents the correct chronological order?
(A) 2, 3, 4, 1
(B) 1, 2, 3, 4
(C) 2, 4, 1, 3
(D) 3, 2, 1, 4

15. What phenomenon is characterized by the anomalous warming of the surface waters in the eastern tropical Pacific Ocean?
(A) El Nino
(B) La Nina
(C) Western disturbance
(D) Indian monsoon

16. Which of the following statements about weathering is incorrect?
(A) Physical weathering breaks rocks into pieces without changing chemistry.
(B) Weathering processes only occur in hot and humid tropical climates.
(C) Chemical weathering involves the alteration of mineral compositions.
(D) Weathering is a standard prerequisite for the process of erosion.

17. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The Cation Exchange Capacity (CEC) of soil is largely controlled by the amount and type of clay minerals and organic matter.
Reason (R) : Clay minerals and organic matter have negatively charged surfaces that can attract and hold positively charged ions (cations).

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roles, maintaining the overall health of the environment.

259. (C) The natural filtration of water by a wetland ecosystem.
Ecosystem services encompass the wide range of benefits that humans obtain from properly functioning natural environments. These include essential processes like air purification, crop pollination, and climate regulation. The natural filtration of water by wetlands exemplifies such a service, as these biological systems remove pollutants and improve water quality, providing a vital resource for human health and various industrial and agricultural activities.

260. (A) A greater density and diversity of species compared to the adjoining communities.
An ecotone is a unique transition area situated between two different biological communities, such as a forest and a grassland. These zones are characterized by the edge effect, which often results in a higher density and diversity of species than what is found in the adjoining ecosystems. This occurs because the ecotone provides a diverse array of resources suitable for various specialized organisms.

261. (D) Living near the environment's carrying capacity with high investment in offspring.
K-selected species utilize a life history strategy adapted to stable environments where populations typically exist near the carrying capacity. These organisms generally have lower reproductive rates but invest significant energy and resources into the survival of their few offspring. Examples include large mammals that exhibit slow growth, long lifespans, and intensive parental care to ensure the success of the next generation.

262. (B) Disproportionately large impact on the community structure relative to its abundance.
A keystone species plays a critical role in maintaining the structure and integrity of an ecological community. Although these species may not be the most abundant, their influence on the environment is disproportionately large relative to their population size. Their presence or absence can lead to significant changes in the ecosystem, affecting the diversity and survival of numerous other species within that habitat.

263. (C) A density-dependent regulatory factor.
Population regulation involves factors that influence growth based on the number of individuals in a given area. Density-dependent factors, such as competition, predation, and disease transmission, become more intense as population density increases. When a disease spreads more rapidly in a crowded group of organisms, it acts as a regulatory mechanism that naturally limits population size, preventing it from exceeding available resources.

264. (D) A network of spatially separated populations connected by migration.
A metapopulation consists of a network of semi-isolated, spatially separated populations of the same species that are connected through the migration of individuals. This concept highlights the dynamic interactions between local groups, where movement between patches allows for genetic exchange and the recolonization of areas where local extinctions may occur. It is a vital framework for understanding species persistence in fragmented landscapes.

265. (A) The maximum population size that an environment can sustainably support.
Carrying capacity represents the maximum population size of a particular species that a specific environment can sustainably support over the long term. This limit is determined by the availability of essential resources such as food, water, and suitable habitat space. When a population reaches this threshold, growth rates typically stabilize as competition for limited resources increases, balancing birth and death rates.

266. (B) Allelopathy.
Allelopathy is a specialized form of interference competition where an organism produces and releases specific biochemicals into the environment. These substances directly influence the growth, survival, and reproduction of other nearby organisms. This interaction allows certain plants or microbes to inhibit the development of potential competitors, effectively securing more space and resources for themselves within a shared biological community or habitat.

267. (B) Can cause significant harm to native species and ecological balance.

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(A) 1 and $_2$ only
(B) 3 and 4 only
(C) 1, 2 and 3
(D) All of the above

26. Which of the following is NOT a major process in the formation of soil?
(A) Magmatic crystallization
(B) Additions of organic matter
(C) Losses of material due to leaching
(D) Transformation of minerals

27. According to the geochemical classification of elements, elements that are concentrated in silicate minerals are called:
(A) Siderophile
(B) Chalcophile
(C) Atmophile
(D) Lithophile

28. Which of the following elements is most abundant in the Earth's crust by weight?
(A) Iron
(B) Oxygen
(C) Silicon
(D) Aluminum

29. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The study of paleoclimate relies on proxy data from sources like ice cores, tree rings, and ocean sediments.
Reason (R) : Direct instrumental records of climate are available for the entire geological history of the Earth.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

30. The term 'partitioning of elements' during surficial geologic processes refers to:
(A) The uniform distribution of elements in all geological materials.
(B) The radioactive decay of elements over extended geological time.
(C) The synthesis of entirely new elements within the Earth's crust.
(D) The segregation and concentration of elements into distinct phases.

31. Geochemical recycling of elements is a fundamental concept. Which of the following is the best example of this process?
(A) Carbon movement between the atmosphere, oceans, and biosphere.
(B) The formation of basic igneous rocks from subterranean magma.
(C) The nucleosynthesis of heavy elements within maturing stars.
(D) The physical breakdown of rock into smaller angular fragments.

32. The 'Goldschmidt classification' is a geochemical classification of elements. Which category includes elements that are typically found in the Earth's core?
(A) Lithophile (rock-loving)
(B) Siderophile (iron-loving)
(C) Chalcophile (ore-loving)
(D) Atmophile (gas-loving)

33. Which of the following represents the largest reservoir of fresh water on Earth?
(A) Rivers and lakes
(B) Glaciers and ice caps
(C) Groundwater
(D) Atmosphere

34. Consider the following statements about water on Earth:
1. The vast majority of Earth's water is saline.
2. Groundwater represents a larger volume of fresh water than all lakes and rivers combined.
3. The hydrosphere includes water in liquid, solid, and gaseous forms.
4. The total amount of water on Earth is constantly and rapidly decreasing.

Which of the above statement(s) is/are correct?
(A) 1 and $_2$ only
(B) 1, 2 and 3
(C) 3 and 4 only
(D) 1, 2, 3 and 4

35. Darcy's Law describes the flow of a fluid through a porous medium. What does it state?
(A) Flow rate is inversely proportional to gradient and conductivity.
(B) Flow rate is directly proportional to viscosity

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and inverse to area.
(C) Flow rate is proportional to area, conductivity, and gradient.
(D) Flow rate is constant regardless of the properties of the medium.

36. Which of the following is a major groundwater province of India known for its extensive alluvial aquifers?
(A) The Deccan Traps
(B) The Cuddapah basin
(C) The Aravalli range
(D) The Indo-Ganga-Brahmaputra plains

37. Match the items in List I with those in List II and select the correct option.
List I (Hydrogeological Term):
P. Hydraulic Conductivity
Q. Aquifer
R. Aquitard
S. Groundwater Fluctuation
List II (Definition):
1. A geological formation that can store and transmit significant quantities of water
2. The seasonal or long-term rise and fall of the water table
3. A measure of a material's capacity to transmit water
4. A low-permeability layer that hinders groundwater movement
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-4, S-3

38. Land subsidence is a potential consequence of:
(A) Excessive recharge of groundwater.
(B) Excessive withdrawal of groundwater.
(C) Low hydraulic conductivity of an aquifer.
(D) The use of groundwater tracers.

39. The Ghyben-Herzberg relation describes:
(A) The flow of water in an unsaturated zone.
(B) The rate of land subsidence due to groundwater extraction.
(C) The chemical evolution of groundwater along a flow path.
(D) The relationship between fresh and saline groundwater in coastal aquifers.

40. Read the following statements and select the correct option.
Statement I : Darcy's Law is valid for all flow conditions, including turbulent flow.
Statement II : Hydraulic conductivity is a property of the porous medium and the fluid.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

41. What is the primary purpose of using groundwater tracers?
(A) To purify contaminated groundwater.
(B) To measure the hydraulic conductivity of an aquifer.
(C) To determine the velocity and flow path of groundwater.
(D) To increase the storage capacity of an aquifer.

42. Consider the following statements about groundwater pollution:
1. Point source pollution originates from a specific location.
2. Non-point source pollution comes from diffuse sources.
3. Agricultural runoff is a common non-point source.
4. Leaking underground tanks are an example of non-point source pollution.
5. Natural geological formations can be a contamination source (e.g., arsenic).
Which of the above statement(s) is/are correct?
(A) 1, 2, 3 and 4
(B) 2, 3, 4 and 5
(C) 1, 2, 3 and 5
(D) 1, 3, 4 and 5

43. Which of the following is a major environmental concern associated with the exploration and exploitation of non-renewable resources like coal?
(A) Enhancement of biodiversity
(B) Improvement in air quality
(C) Increase in groundwater recharge
(D) Land degradation and water pollution

44. The 'historical perspective' on conservation of non-renewable resources emphasizes:
(A) The need to accelerate extraction to fuel

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economic growth.
(B) The realization that resources are finite and require judicious use.
(C) The idea that technology will always provide substitutes.
(D) The belief that conservation is an obstacle to development.

45. Which of the following is NOT classified as a catastrophic geological hazard?
(A) Earthquake
(B) Volcanism
(C) Soil erosion
(D) Tsunami

46. What is the primary goal of hazard mitigation?
(A) To completely prevent natural hazards from occurring.
(B) To increase the economic benefits from a hazardous event.
(C) To accurately predict the exact time and location of every hazard.
(D) To reduce the loss of life and property by lessening impacts.

47. Consider the following geological hazards:
1. Drought
2. Earthquake
3. Landslide

Which of the following represents the correct order of their typical speed of onset, from fastest to slowest?
(A) 2, 3, 1
(B) 1, 3, 2
(C) 3, 1, 2
(D) 2, 1, 3

48. A sudden and intense rainfall in a small area, leading to flash floods, is known as a:
(A) Western disturbance
(B) Cloud burst
(C) La Nina event
(D) Geostrophic wind

49. Tsunamis are most commonly generated by:
(A) Strong sustained winds during a major hurricane.
(B) Large-scale underwater earthquakes at subduction zones.
(C) The cyclical gravitational pull of the moon and sun.
(D) Heavy and prolonged rainfall in coastal regions.

50. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : Prediction of earthquakes with high precision regarding time, location, and magnitude is currently a major challenge.
Reason (R) : The processes leading to a major earthquake involve complex and chaotic interactions deep within the Earth's crust.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

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51. The concept of 'steady state' in Earth systems implies that:
(A) No energy or matter is entering or leaving the system.
(B) Input equals output, maintaining a dynamic balance.
(C) The system is static and completely unchanging.
(D) The system is in a state of terminal decline.

52. In the context of Earth's thermal environment, the primary reason for the seasons is:
(A) The tilt of the Earth's rotational axis with respect to its orbital plane.
(B) The changing distance between the Earth and the Sun.
(C) The amount of volcanic activity releasing heat from the interior.
(D) The cyclical variation in the Sun's energy output.

53. Consider the following forces acting on air parcels:
1. Pressure Gradient Force
2. Coriolis Force
3. Frictional Force

A gradient wind, which flows along curved isobars, represents a balance between which of these forces?
(A) 1 only
(B) 1 and 2 only
(C) 1, 2 and 3
(D) None of the above

(D) The tracer moves with groundwater to track velocity.

112. Read the following statements and select the correct option.
Statement I : The excessive use of groundwater in coastal areas can lead to saltwater intrusion.
Statement II : The Ghyben-Herzberg relation shows that lowering the freshwater table allows the denser saline water to move inland.
(A) Both Statement I and II are true; II explains I.
(B) Both Statement I and II are true; II does not explain I.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

113. 'Hydrology' is the scientific study of:
(A) The solid mineral material of the Earth's crust.
(B) The living organisms of the Earth.
(C) Water movement, distribution, and management on Earth.
(D) The gases surrounding the Earth.

114. Which of these is a major groundwater province of India characterized by hard rock formations?
(A) The Gangetic Plains
(B) The Brahmaputra Valley
(C) The coastal plains of Kerala
(D) The Peninsular Shield (including parts of the Deccan)

115. A historical perspective on the conservation of non-renewable resources leads to the conclusion that:
(A) Sustainable management through recycling and substitution is necessary.
(B) These essential mineral resources will never run out.
(C) The environmental impacts of extraction are largely negligible.
(D) Conservation efforts generally hinder modern economic progress.

116. Which of the following hazards is of tectonic origin?
(A) Flood
(B) Earthquake
(C) Drought
(D) Cloud burst

117. The prediction of which natural hazard has seen the most improvement and success, often allowing for timely evacuations?
(A) Earthquakes
(B) Landslides
(C) Hurricanes (Cyclones)
(D) Volcanic Plinian eruptions

118. A tsunami is a series of large waves generated by a sudden displacement of a large volume of water. Which event is the LEAST likely to cause a tsunami?
(A) A major submarine earthquake
(B) An intense hurricane
(C) A large coastal landslide falling into the sea
(D) A submarine volcanic eruption

119. Consider the following layers of the Earth:
1. Crust
2. Mantle
3. Inner Core
4. Outer Core

Which of the following represents the correct order from the center outwards?
(A) 3, 4, 2, 1
(B) 4, 3, 2, 1
(C) 1, 2, 4, 3
(D) 2, 3, 1, 4

120. Which of the following defines a 'rock'?
(A) A solid aggregate of one or more minerals or mineraloids.
(B) A naturally occurring, inorganic solid with a definite chemical composition.
(C) A liquid molten material found beneath the Earth's surface.
(D) The unconsolidated material covering the Earth's surface.

121. Consider the following statements related to landform controls:
1. Tectonic forces are responsible for creating primary landforms like mountains.
2. Climatic forces, like weathering and erosion, modify and sculpt these landforms.
3. Plate tectonics is the theory that explains the movement of continental and oceanic plates.
4. Human activities have no impact on the formation of landforms.

Which of the above statement(s) is/are correct?

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63. Which type of clay mineral is known for its high shrink-swell potential, making it problematic for construction?
(A) Kaolinite
(B) Illite
(C) Smectite (e.g., Montmorillonite)
(D) Chlorite

64. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : Soils in tropical rainforests are often nutrient-poor despite the lush vegetation.
Reason (R) : Heavy rainfall in tropical regions leads to intense leaching of nutrients from the topsoil.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

65. Identify the incorrect statement regarding weathering reactions.
(A) Frost action is a form of chemical weathering.
(B) Oxidation is a chemical weathering process that commonly affects iron-bearing minerals.
(C) Carbonation, involving carbonic acid, is important in the weathering of limestone.
(D) Biological activity can contribute to both physical and chemical weathering.

66. The measure of a soil's ability to hold and exchange cations is known as:
(A) pH
(B) Cation Exchange Capacity (CEC)
(C) Soil porosity
(D) Hydraulic conductivity

67. Which of the following is NOT a primary process of soil formation?
(A) Additions of organic and mineral materials to the soil.
(B) Losses of materials by erosion and leaching.
(C) Subduction of tectonic plates beneath the soil.
(D) Translocations of materials within the soil profile.

68. What are the three main components used to determine soil texture?
(A) Water, air, and organic matter
(B) Bedrock, regolith, and topsoil
(C) Iron, aluminum, and silicon oxides
(D) Sand, silt, and clay

69. Read the following statements and select the correct option.
Statement I : The physical and chemical properties of a soil are primarily determined by its parent material.
Statement II : Climate, organisms, relief, and time are also crucial factors that influence soil development and its properties.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

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70. The final stage of eroded material, where it is laid down in a new location, is called:
(A) Weathering
(B) Deposition
(C) Transportation
(D) Erosion

71. Consider the following statements about soil mineralogy:
1. Clay minerals are secondary minerals formed by weathering.
2. Quartz is highly resistant to weathering and is common in sandy soils.
3. The type of clay significantly affects CEC and plasticity.
4. All soils are composed entirely of clay minerals.
5. Clay mineral identification often requires X-ray diffraction.

Which of the above statement(s) is/are correct?
(A) 1, 2, 3 and 4
(B) 2, 3, 4 and 5
(C) 1, 2, 3 and 5
(D) 1, 3, 4 and 5

72. In the geochemical classification of elements, 'Atmophile' elements are those that:
(A) Concentrate in the Earth's core.
(B) Readily form sulfide ores.
(C) Are concentrated in the silicate crust.
(D) Are found predominantly as gases in the

(D) The specific pattern of tree growth on the slopes.

93. Read the following statements and select the correct option.
Statement I : Mitigation strategies for landslides include constructing retaining walls and improving drainage on slopes.
Statement II : The prediction of the exact moment a landslide will occur is highly accurate and reliable.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

94. What is an avalanche?
(A) A flow of molten rock from a volcano.
(B) A violent, rotating column of air.
(C) A crack in the Earth's crust.
(D) A rapid flow of snow down a slope.

95. Consider the following statements regarding hazards and their mitigation:
1. Early warning systems are a key component of tsunami mitigation.
2. Building codes in earthquake-prone areas are designed to make structures more resilient.
3. Flood mitigation can involve both structural measures (e.g., levees) and non-structural measures (e.g., zoning).
4. The primary goal of hazard prediction is to prevent the natural event from occurring.

Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 3 and 4 only
(C) 1, 2 and 3
(D) 1, 2, 3 and 4

96. Which of the following best describes the energy budget of the Earth?
(A) The balance between incoming solar radiation and outgoing terrestrial radiation.
(B) The process of heat transfer from the core to the crust.
(C) The total amount of fossil fuel reserves on the planet.
(D) The energy generated by radioactive decay within the Earth.

97. The primary control on the formation of igneous rocks is the:
(A) Amount of pressure applied to the rock.
(B) Rate of cooling of magma or lava.
(C) Type of sediment that is compacted.
(D) Amount of water present during weathering.

98. A geostrophic wind is a theoretical wind that results from an exact balance between which two forces?
(A) Pressure gradient force and Frictional force
(B) Coriolis force and Frictional force
(C) Pressure gradient force and Coriolis force
(D) Gravitational force and Pressure gradient force

99. Which of the following statements about La Nina is correct?
(A) It involves the unusual warming of the central and eastern tropical Pacific Ocean.
(B) It typically leads to drought conditions in Australia and Indonesia.
(C) It is another name for the Indian monsoon.
(D) It is the cool phase of the El Niño-Southern Oscillation (ENSO) cycle.

100. Match the items in List I with those in List II and select the correct option.
List I (Earth Layer):
P. Inner Core
Q. Outer Core
R. Mantle (Asthenosphere)
S. Crust
List II (Primary State of Matter):
1. Liquid
2. Solid
3. Solid but brittle
4. Plastic/Partially molten
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

101. The concept of residence time is crucial for understanding natural cycles. A substance with a very long residence time in a reservoir:
(A) Is removed from the reservoir very quickly.
(B) Is highly reactive and transforms rapidly.
(C) Remains in the reservoir for a long period.
(D) Has a very small total mass in the reservoir.

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the depth of the freshwater-saltwater interface below sea level is approximately:
(A) 20 times the head
(B) 40 times the head
(C) 60 times the head
(D) Equal to the head

83. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : Uncontrolled and excessive use of groundwater can lead to the drying up of wells and land subsidence.
Reason (R) : Pumping groundwater faster than it is naturally replenished lowers the water table and can cause compaction of aquifer sediments.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

84. The validity of Darcy's Law is generally limited to:
(A) Turbulent flow conditions
(B) Flow in non-porous media
(C) Laminar flow conditions
(D) Flow of compressible fluids only

85. Which of the following is a potential source of Arsenic contamination in groundwater?
(A) Industrial effluents from the textile industry.
(B) Natural geological formations rich in arsenic-bearing minerals.
(C) Excessive use of nitrogen-based fertilizers.
(D) Acid rain leaching lead from pipes.

86. Which term describes a material's ability to transmit water, often quantified as 'K' in Darcy's Law?
(A) Porosity
(B) Specific yield
(C) Storativity
(D) Hydraulic conductivity

87. Identify the incorrect pair.
(A) Conservation of non-renewables - Promoting indefinite use
(B) Natural Resource Exploration - Potential for land disturbance
(C) Resource Exploitation - Risk of pollution
(D) Historical Perspective on resources - Awareness of finiteness

88. Which of the following is the most significant long-term environmental concern related to the exploitation of fossil fuels?
(A) The creation of temporary employment.
(B) The aesthetic impact of mining operations.
(C) The contribution to anthropogenic climate change through greenhouse gas emissions.
(D) The depletion of sand and gravel for construction.

89. A landslide is best defined as:
(A) The movement of rock, debris, or earth down a sloped section of land.
(B) The shaking of the ground due to the release of seismic energy.
(C) A large ocean wave caused by an underwater disturbance.
(D) An overflow of a large amount of water onto normally dry land.

90. Consider the following events in a river basin:
1. Intense, prolonged rainfall over the catchment area.
2. Soil becomes saturated, increasing surface runoff.
3. River discharge exceeds bankfull capacity.
4. Water inundates the floodplain.

Which of the following represents the likely chronological sequence leading to a major flood?
(A) 1, 2, 3, 4
(B) 2, 1, 3, 4
(C) 3, 4, 1, 2
(D) 1, 3, 2, 4

91. All of the following are considered catastrophic geological hazards EXCEPT:
(A) Volcanism
(B) Acid rain
(C) Avalanche
(D) Earthquake

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92. The prediction of volcanic eruptions has become more reliable due to the monitoring of:
(A) Fluctuations in the Earth's local magnetic field.
(B) The surface water level in distant rivers.
(C) Ground deformation, seismicity, and gas emissions.

atmosphere and hydrosphere.

73. The study of past climates is known as:
(A) Paleoclimatology
(B) Hydrogeology
(C) Geochronology
(D) Petrology

74. Which of the following is the most abundant element in the bulk Earth (including core, mantle, and crust)?
(A) Oxygen
(B) Silicon
(C) Iron
(D) Magnesium

75. Match the items in List I with those in List II and select the correct option.
List I (Goldschmidt Classification):
P. Lithophile
Q. Siderophile
R. Chalcophile
S. Atmophile
List II (Example Element):
1. Copper (Cu)
2. Nitrogen (N)
3. Silicon (Si)
4. Iron (Fe)
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

76. The partitioning of an element like lead (Pb) during surficial geologic processes might involve its:
(A) Concentration in sulfide minerals during ore formation.
(B) Adsorption onto clay particles in soil.
(C) Incorporation into the crystal lattice of calcite.
(D) All of the above.

77. Which of the following is NOT a proxy used in paleoclimate studies?
(A) Isotopic ratios in ice cores
(B) Tree ring widths
(C) Fossil pollen distribution in sediments
(D) Real-time satellite temperature data

78. The geochemical recycling of phosphorus is different from that of carbon or nitrogen primarily because:
(A) Phosphorus does not have a significant gaseous phase in its cycle.
(B) Phosphorus is not an essential nutrient for life.
(C) The phosphorus cycle is much faster than the carbon cycle.
(D) Phosphorus is mainly stored in the atmosphere.

79. Read the following statements and select the correct option.
Statement I : The abundance of elements in the hydrosphere is identical to their abundance in the Earth's crust.
Statement II : The solubility of minerals and the residence time of elements in water control their concentration in the hydrosphere.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

80. What is the term for the science that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust?
(A) Hydrogeology
(B) Hydrology
(C) Limnology
(D) Oceanography

81. Consider the following statements regarding groundwater in India:
1. The Indo-Ganga-Brahmaputra plains are a major groundwater province.
2. The Deccan Trap basalts form a porous, unproductive aquifer system.
3. Over-extraction is a major concern in many agricultural regions.
4. Groundwater quality is uniformly excellent across the country.
Which of the above statement(s) is/are correct?
(A) 1 and 3 only
(B) 2 and 4 only
(C) 1, 2 and 3
(D) All of the above

82. According to the Ghyben-Herzberg relation, for every unit of fresh water head above sea level,

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102. In soil science, what does 'cation exchange capacity' (CEC) measure?
(A) The soil's ability to conduct electricity.
(B) The soil's capacity to hold and supply nutrient cations like Ca_2^+, Mg_2^+, and K^+.
(C) The total amount of water the soil can hold.
(D) The rate at which water infiltrates the soil.

103. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : Chemical weathering proceeds more rapidly in hot, humid climates than in cold, dry climates.
Reason (R) : The presence of heat and water accelerates the rates of chemical reactions such as hydrolysis and oxidation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

104. Which of the following correctly identifies the processes of sediment handling, in order?
(A) Weathering, Erosion, Transportation, Deposition
(B) Deposition, Transportation, Erosion, Weathering
(C) Erosion, Deposition, Weathering, Transportation
(D) Transportation, Weathering, Erosion, Deposition

105. Consider the following statements regarding soil:
1. Soil physical properties refer to its mineral composition.
2. Climate control on soil formation is a dominant factor.
3. Soil formation is a result of physical, chemical, and biological processes.
4. Clay minerals are primarily identified by their color.
5. Cation exchange capacity is mainly controlled by the sand fraction.

Which of the above statement(s) is/are correct?
(A) 1 and 4
(B) 2 and 3
(C) 3, 4 and 5
(D) 1, 2 and 3

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106. The process of soil formation is best described as:
(A) A rapid process of rock decay that takes a few months.
(B) A complex and slow process involving weathering and transformation.
(C) The simple accumulation of dust and sand transported by wind.
(D) The crystallization of minerals from a cooling magma at the surface.

107. Which of the following is NOT a soil forming mineral?
(A) Feldspar
(B) Mica
(C) Magma
(D) Quartz

108. The abundance of elements in the Earth's crust is significantly different from the abundance in the bulk Earth because of:
(A) The continuous addition of material from meteorites.
(B) The effect of the moon's gravitational pull.
(C) The development of life in the biosphere.
(D) The process of primary geochemical differentiation.

109. What is paleoclimate?
(A) The study of the climate of other planets.
(B) The future projection of climate change based on computer models.
(C) The climate of a past period in the Earth's history.
(D) The study of microclimates in urban areas.

110. Which group of elements in the geochemical classification is described as 'ore-loving' and tends to form sulfide minerals?
(A) Lithophile
(B) Chalcophile
(C) Siderophile
(D) Atmophile

111. What is the fundamental principle behind using groundwater tracers?
(A) The tracer purifies the water as it moves.
(B) The tracer reacts with contaminants to neutralize them.
(C) The tracer increases the water's hydraulic conductivity.

54. 'Western disturbances' are extratropical storms that bring sudden winter rain to the northwestern parts of the Indian subcontinent. From which body of water do they primarily originate?
(A) Bay of Bengal
(B) Arabian Sea
(C) Indian Ocean
(D) Mediterranean Sea

55. Match the items in List I with those in List II and select the correct option.
List I (Phenomenon):
P. El Nino
Q. La Nina
R. Indian Monsoon
S. Drought
List II (Primary Characteristic):
1. Seasonal reversal of wind direction
2. Anomalous cooling of the eastern tropical Pacific
3. Prolonged period of below-average precipitation
4. Anomalous warming of the eastern tropical Pacific
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-2, R-1, S-3
(C) P-4, Q-1, R-2, S-3
(D) P-3, Q-2, R-1, S-4

56. Which of the following identifies a correct statement regarding the Earth's formation?
(A) Atmosphere and hydrosphere formed before the solid crust.
(B) Primary differentiation was driven by material density.
(C) Core, mantle, and crust formed from a homogenous mixture.
(D) The Earth's initial atmosphere was naturally rich in oxygen.

57. The frictional force affecting wind is most significant:
(A) At high altitudes, near the top of the troposphere.
(B) Over large, smooth ocean surfaces.
(C) At the equator, where the Coriolis force is zero.
(D) Near the Earth's surface, especially over rough terrain.

58. Read the following statements and select the correct option.
Statement I : Plate tectonic activity is a major control on the formation of large-scale landforms like mountain ranges and ocean trenches.
Statement II : Climatic processes like glaciation and river erosion shape and modify landforms created by tectonic forces.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

59. The concept of geophysical fields includes all of the following EXCEPT:
(A) The Earth's gravitational field.
(B) The Earth's magnetic field.
(C) The Earth's biological field.
(D) The Earth's thermal field.

60. Consider the following statements about rock formation:
1. Igneous rocks can be either intrusive (plutonic) or extrusive (volcanic).
2. Metamorphic rocks always melt completely during their formation.
3. Sedimentary rocks are formed from the weathered products of other rocks.
4. The rock cycle describes the processes by which rocks are formed, altered, and destroyed.
Which of the above statement(s) is/are correct?
(A) 1 and $_2$ only
(B) 1, 3 and 4
(C) 2 and 3 only
(D) 1, 2, 3 and 4

61. What is the most significant control on the type of soil that forms in a particular region?
(A) The age of the parent rock.
(B) The longitude of the location.
(C) The local magnetic field.
(D) The climate of the region.

62. The process by which water-soluble salts accumulate in the soil, potentially leading to a decline in soil fertility, is called:
(A) Leaching
(B) Salinization
(C) Laterization
(D) Humification

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(A) 1 and 2 only
(B) 1, 2 and 3
(C) 3 and 4 only
(D) 1, 2, 3 and 4

122. The deflection of winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere is caused by the:
(A) Pressure gradient force
(B) Coriolis force
(C) Frictional force
(D) Centrifugal force

123. The Indian summer monsoon is typically associated with:
(A) Dry, cold winds blowing from the land towards the sea.
(B) The passage of western disturbances.
(C) Moist, warm winds blowing from the sea towards the land.
(D) The development of a strong La Nina event.

124. What is a 'mineral'?
(A) A man-made solid substance.
(B) A mixture of different rock fragments.
(C) Any substance that can be mined from the Earth.
(D) A naturally occurring solid with definite composition and structure.

125. Match the items in List I with those in List II and select the correct option.
List I (Weathering Process):
P. Frost Wedging
Q. Oxidation
R. Carbonation
S. Hydrolysis
List II (Description):
1. Reaction of minerals with carbonic acid, common in limestone
2. Physical breakup of rock by freezing and thawing of water
3. Chemical reaction of minerals with water
4. Reaction of minerals with oxygen, e.g., rusting
(A) P-1, Q-3, R-2, S-4
(B) P-2, Q-4, R-1, S-3
(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-4, R-1, S-2

126. The fine-grained material transported by wind, water, or ice is collectively known as:
(A) Bedrock
(B) Magma
(C) Regolith
(D) Sediments

127. Which of the following soil properties has the greatest influence on nutrient holding capacity?
(A) Cation Exchange Capacity (CEC)
(B) Soil color
(C) Soil temperature
(D) Soil porosity

128. The process of soil formation is often summarized by the acronym CLORPT. What does the 'R' stand for?
(A) Rain
(B) Rock
(C) Relief (topography)
(D) Residence time

129. Identify the correct statement about clay minerals.
(A) They have layered structures and net negative charges.
(B) They are primary minerals inherited directly from igneous rocks.
(C) They are typically large, sand-sized particles.
(D) They are completely insoluble and inert in the soil environment.

130. Consider the following statements about geochemical cycles:
1. They involve the movement of elements through different reservoirs.
2. The partitioning of elements depends on their chemical properties.
3. Geochemical recycling ensures that essential elements are available for life.
4. All elements recycle at the same rate.
5. Paleoclimate does not influence geochemical cycles.
Which of the above statement(s) is/are correct?
(A) 1, 2 and 3
(B) 2, 3 and 4
(C) 1, 4 and 5
(D) 1, 2, 3, 4 and 5

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(A) Tectonic activity
(B) The Earth's Van Allen belts
(C) Climate
(D) Rock type

195. Consider the following statements about the Indian Climate:
1. The Indian Monsoon is a seasonal reversal of winds driven by differential heating.
2. Western disturbances cause winter precipitation in North India.
3. El Nino events are consistently linked to stronger-than-average monsoons.
4. La Nina is associated with the warming of the Pacific Ocean.

Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 3 and 4 only
(C) 1, 2 and 3
(D) 1, 2 and 4

196. The process of 'weathering' can be best described as:
(A) The transport of rock fragments by wind.
(B) The cementation of loose sediments into rock.
(C) The melting of rock due to intense heat.
(D) The in-place disintegration of surface rock.

197. Which of the following is a key process in chemical weathering?
(A) The dissolution of minerals by acidic water.
(B) Abrasion by wind-blown sand.
(C) Freeze-thaw action in cracks.
(D) The breaking of rocks by plant roots.

198. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The geological history of an area is a major factor in determining its natural resource potential.
Reason (R) : Processes like magmatism, sedimentation, and metamorphism concentrate elements and compounds into economically viable deposits.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

199. The study of the distribution of water in the various reservoirs of the Earth (ice, groundwater, surface water) is part of:
(A) Geochemistry
(B) Paleoclimatology
(C) Global Hydrology
(D) Petrology

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200. Match the items in List I with those in List II and select the correct option.
List I (Hazard):
P. Earthquake
Q. Flood
R. Landslide
S. Volcano
List II (Mitigation Measure):
1. Slope stabilization and drainage control
2. Monitoring of seismicity and gas emissions
3. Construction of levees and floodwalls
4. Enforcement of seismic building codes
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-1, S-4

201. Which of the following is a primary control on a soil's physical properties?
(A) The age of the moon.
(B) The magnetic polarity of the bedrock.
(C) The distance to the nearest ocean.
(D) The relative proportions of sand, silt, and clay.

202. The geochemical classification of elements is based on:
(A) Their absolute atomic weight.
(B) Their affinity for silicate, metal, or gas phases.
(C) Their current global market value.
(D) Their potential for radioactivity.

203. Read the following statements and select the correct option.
Statement I : Land subsidence is the gradual or sudden sinking of the Earth's surface.
Statement II : Excessive groundwater withdrawal is a major anthropogenic cause of land subsidence.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.

stability that the system tends towards over time.
(B) No energy or matter is entering or leaving the system.
(C) A rapid and catastrophic change in the system's state.
(D) The continuous flow of matter and energy through the system.

143. Consider the following processes of the rock cycle:
1. Melting into magma
2. Weathering and erosion to form new sediments
3. Metamorphism due to heat and pressure
4. Cooling and crystallization into an igneous rock

Which of the following represents a possible logical sequence, starting with an existing sedimentary rock?
(A) 2, 3, 1, 4
(B) 3, 1, 4, 2
(C) 1, 4, 2, 3
(D) 2, 1, 4, 3

144. In which of the following locations would the Coriolis force be strongest?
(A) At the Equator
(B) At 30 degrees latitude
(C) At 60 degrees latitude
(D) At the North Pole

145. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The Earth's energy budget is a closed system with no external inputs.
Reason (R) : The primary source of energy for Earth's climate system is solar radiation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

146. Which process is responsible for the formation of metamorphic rocks?
(A) Compaction and cementation of sediments
(B) Alteration of pre-existing rocks by heat and pressure without melting
(C) Cooling and solidification of lava
(D) Weathering of surface rocks by wind and water

147. Identify the correct pair.
(A) Igneous Rock - Formed from cemented sediments
(B) Metamorphic Rock - Formed from cooling magma
(C) Sedimentary Rock - Formed by alteration from heat and pressure
(D) Igneous Rock - Formed from solidification of magma

148. Read the following statements and select the correct option.
Statement I : Physical weathering increases the surface area of rocks, making them more susceptible to chemical weathering.
Statement II : Chemical weathering can weaken rocks, making them more susceptible to physical weathering.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

149. The process by which soil particles are lifted and carried away by wind or water is known as:
(A) Infiltration
(B) Deposition
(C) Erosion
(D) Pedogenesis

150. Consider the following factors influencing soil formation:
1. Parent Material
2. Climate
3. Organisms
4. Relief (Topography)
5. Time

Which of these factors is considered passive?
(A) Parent Material
(B) Climate
(C) Organisms
(D) Time

151. Which of the following is a chemical property of soil?
(A) Texture
(B) Structure
(C) Porosity

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131. In the context of elemental abundance, which sphere contains the highest concentration of gaseous elements like Nitrogen and Argon?
(A) Crust
(B) Hydrosphere
(C) Biosphere
(D) Atmosphere

132. The primary driving force for the geochemical recycling of many elements is:
(A) The Earth's magnetic field.
(B) The flow of energy from the sun and the Earth's interior.
(C) The gravitational pull of the moon.
(D) The radioactive decay of potassium-40.

133. According to Darcy's Law, if the hydraulic gradient is doubled while all other factors remain constant, the groundwater flow rate will:
(A) Be halved.
(B) Remain the same.
(C) Be doubled.
(D) Be quadrupled.

134. A geological formation that does not transmit or store significant amounts of water, such as unfractured crystalline rock, is called an:
(A) Aquifer
(B) Aquitard
(C) Aquiclude
(D) Aquifuge

135. What is the most likely cause of land subsidence in a region with extensive groundwater extraction?
(A) Pore water removal leading to sediment compaction.
(B) The weight of the overlying buildings increases.
(C) The water table rises, pushing the ground surface down.
(D) Chemical reactions dissolve the rock, creating voids.

136. Which of the following is a non-renewable resource?
(A) Solar energy
(B) Natural gas
(C) Wind energy
(D) Geothermal energy

137. Which of these is a key aspect of natural resource conservation?
(A) Maximizing the rate of extraction for short-term economic gain.
(B) Preventing any and all use of natural resources.
(C) Ensuring the sustainable use of resources for present and future generations.
(D) Exporting all raw resources without processing.

138. Which natural hazard is measured using the Richter or Moment Magnitude Scale?
(A) Flood
(B) Volcano
(C) Landslide
(D) Earthquake

139. Read the following statements and select the correct option.
Statement I : Avalanche prediction involves assessing snowpack stability, weather conditions, and terrain.
Statement II : It is possible to predict the exact time and size of an avalanche with perfect accuracy weeks in advance.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

140. A 'lahar' is a specific type of natural hazard associated with volcanoes. What is it?
(A) A cloud of hot gas and ash.
(B) A flow of molten lava.
(C) A volcanic-induced earthquake.
(D) A destructive mudflow or debris flow on the slopes of a volcano.

141. The primary geochemical differentiation of Earth led to the formation of a dense, iron-rich core and a less dense silicate mantle. This separation occurred primarily due to:
(A) Magnetic attraction
(B) Chemical reactions with water
(C) Gravitational forces
(D) The solar wind

142. The concept of equilibrium in an Earth system refers to:
(A) A state of minimum energy and maximum

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(B) The elliptical shape of the Earth's orbit, bringing it closer and farther from the Sun.
(C) The periodic reversal of the Earth's magnetic poles.
(D) The Earth's axial tilt and its revolution around the Sun.

163. Read the following statements and select the correct option.
Statement I : The gradient wind is an extension of the geostrophic wind concept that accounts for curved flow.
Statement II : In a gradient wind, a centrifugal force acts in addition to the pressure gradient and Coriolis forces.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

164. What is the primary characteristic of a drought?
(A) A single day without rain.
(B) A period of abnormally high temperatures.
(C) A sudden, massive flood.
(D) A prolonged precipitation deficiency causing water shortage.

165. Consider the following statements about weathering and erosion:
1. Weathering is the in-situ breakdown of rock.
2. Erosion involves the transport of weathered material.
3. Transportation is the movement of eroded sediments.
4. Deposition is the final settling of transported sediments.
5. These processes are independent and do not influence each other.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3 only
(B) 1, 2, 3 and 4
(C) 2, 3, 4 and 5
(D) All of the above

166. Which of the following is NOT a type of physical weathering?
(A) Frost wedging
(B) Hydrolysis
(C) Abrasion
(D) Thermal expansion and contraction

167. Which property refers to the arrangement of soil particles into clumps or aggregates?
(A) Soil Texture
(B) Soil Color
(C) Soil pH
(D) Soil Structure

168. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The type of parent material is the sole determinant of the final soil type.
Reason (R) : The processes of soil formation, such as climate and biological activity, significantly modify the parent material over time.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

169. What is the primary control on a soil's Cation Exchange Capacity (CEC)?
(A) The amount of sand in the soil.
(B) The color of the soil.
(C) The amount and type of clay and organic matter.
(D) The depth of the water table.

170. Which of the following best describes the geochemical recycling of elements?
(A) Movement of elements through Earth's various spheres.
(B) The transformation of one element into another through nuclear fusion.
(C) The extraction of elements from ores for industrial use.
(D) The permanent removal of elements from the Earth system.

171. The abundance of elements in the biosphere is primarily controlled by:
(A) The gravitational field of the Earth.
(B) The magnetic properties of the elements.
(C) The industrial demand for certain elements.
(D) The requirements of living organisms.

172. Which of the following is a direct effect of the excessive use of groundwater from an unconfined aquifer?

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(A) An increase in the water level of nearby lakes.
(B) A lowering of the water table.
(C) A decrease in the salinity of the groundwater.
(D) An increase in the hydraulic conductivity of the aquifer.

173. What is the main concern related to the Ghyben-Herzberg relation in coastal communities?
(A) It predicts an increase in seasonal local rainfall.
(B) It describes the process of natural land subsidence.
(C) Over-pumping of fresh groundwater causing saline intrusion.
(D) It models the flow of pollutants from industrial sites.

174. Which of the following is an example of a non-renewable resource?
(A) Timber from a managed forest
(B) Hydropower
(C) Fish from the ocean
(D) Petroleum

175. Match the items in List I with those in List II and select the correct option.
List I (Natural Hazard):
P. Earthquake
Q. Landslide
R. Flood
S. Volcano
List II (Primary Cause/Description):
1. Overflow of water onto dry land
2. Eruption of molten rock and ash
3. Sudden slip on a fault
4. Downslope movement of rock and soil
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

176. Which of the following is a critical component for the prediction of floods?
(A) Monitoring seismic activity.
(B) Monitoring rainfall and river discharge levels.
(C) Measuring ground deformation.
(D) Analyzing the chemical composition of river water.

177. A 'cloud burst' is a natural hazard characterized by:
(A) A prolonged period of gentle rain.
(B) The formation of large hailstones.
(C) Extremely heavy precipitation in a short period over a limited area.
(D) A tornado that forms over water.

178. The formation of the Earth's atmosphere and hydrosphere was a result of:
(A) Capture of gases from the solar wind.
(B) Photosynthesis by early life forms.
(C) Chemical reactions in the upper atmosphere.
(D) Interior outgassing during intense volcanic activity.

179. A rock composed of cemented fragments of pre-existing rocks is classified as:
(A) Sedimentary
(B) Igneous intrusive
(C) Igneous extrusive
(D) Metamorphic

180. The energy budget of the Earth is in a state of dynamic equilibrium. What would be the most likely consequence of a sustained increase in incoming solar radiation without a corresponding increase in outgoing radiation?
(A) The Earth would cool down.
(B) The Earth would warm up.
(C) The seasons would cease to exist.
(D) The Earth's rotation would slow down.

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181. Which phenomenon explains why a cyclone spins counter-clockwise in the Northern Hemisphere?
(A) Pressure Gradient Force
(B) Frictional Force
(C) Coriolis Force
(D) Geostrophic Wind

182. Consider the following components of the soil profile:
1. Bedrock (R Horizon)
2. Topsoil (A Horizon)
3. Subsoil (B Horizon)
4. Parent Material (C Horizon)
Which of the following represents the correct order from the surface downwards?
(A) 2, 3, 4, 1
(B) 1, 2, 3, 4

(C) 2, 4, 3, 1
(D) 4, 3, 2, 1

183. Identify the incorrect statement about soil formation.
(A) Soil formation is also known as pedogenesis.
(B) It involves additions, losses, translocations, and transformations.
(C) Climate and organisms are active factors in soil formation.
(D) The process is very rapid, forming mature soils in a decade.

184. The characterization of clay minerals is important because they:
(A) Are the main source of fossil fuels.
(B) Control key properties like swelling and nutrient retention.
(C) Are always visible to the naked eye.
(D) Only form in desert environments.

185. Read the following statements and select the correct option.
Statement I : The geochemical classification of elements helps in understanding the distribution of mineral resources.
Statement II : Elements with similar geochemical behaviour tend to concentrate in similar geological environments.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

186. The concept of partitioning of elements is critical in understanding:
(A) The formation of ore deposits.
(B) The evolution of magma.
(C) The development of soil profiles.
(D) All of the above.

187. In a coastal aquifer, if the water table is lowered by $_2$ meters due to pumping, according to the Ghyben-Herzberg principle, how much will the freshwater-saltwater interface be expected to rise?
(A) $_2$ meters
(B) 20 meters
(C) 80 meters
(D) 40 meters

188. Groundwater tracers are used to determine:
(A) The age of the groundwater.
(B) The chemical purity of the water.
(C) The depth of the aquifer.
(D) The flow direction and velocity of groundwater.

189. A major environmental concern with large-scale mining is:
(A) The generation of large amounts of waste rock and tailings, which can pollute water.
(B) The creation of new landforms.
(C) The discovery of new mineral types.
(D) The increase in local employment.

190. Which of the following is a primary mitigation strategy for reducing earthquake risk to buildings?
(A) Reporting on a disaster after it has happened.
(B) Constructing buildings according to seismic design codes.
(C) Calculating the total economic loss from a flood.
(D) Conducting a rescue operation during an earthquake.

191. The Mohorovičić discontinuity (Moho) is the boundary between:
(A) The inner core and the outer core.
(B) The mantle and the outer core.
(C) The crust and the mantle.
(D) The lithosphere and the asthenosphere.

192. Which of the following forces is a result of the Earth's rotation?
(A) Gravitational force
(B) Frictional force
(C) Pressure gradient force
(D) Coriolis force

193. The difference between magma and lava is that:
(A) Magma is solid, while lava is liquid.
(B) Magma is surface molten rock; lava is subsurface.
(C) Magma is subsurface molten rock; lava is surface.
(D) There is no difference; the terms are interchangeable.

194. Which of the following is NOT a control on the formation of landforms?

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(D) pH

152. Match the items in List I with those in List II and select the correct option.
List I (Element Class):
P. Siderophile
Q. Lithophile
R. Atmophile
S. Chalcophile
List II (Typical Host):
1. Silicate minerals
2. Sulfide ores
3. Atmosphere
4. Iron core
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-2, R-3, S-1
(D) P-2, Q-3, R-1, S-4

153. The partitioning of elements during the formation of an igneous rock from magma is an example of:
(A) Geochemical recycling.
(B) Surficial geologic processes.
(C) Fractional crystallization.
(D) Chemical weathering.

154. The distribution of water on Earth is highly uneven. What percentage of the Earth's total water is freshwater?
(A) Approximately 10%
(B) Approximately 25%
(C) Approximately 50%
(D) Approximately 3%

155. Which law provides a fundamental description of groundwater flow in a porous medium?
(A) Darcy's Law
(B) Newton's Law of Viscosity
(C) The Ghyben-Herzberg Relation
(D) The Law of Superposition

156. In the context of groundwater, seasonal variations in rainfall and recharge lead to:
(A) Changes in hydraulic conductivity.
(B) Groundwater fluctuations.
(C) The formation of the aquifer.
(D) The validity of Darcy's Law.

157. Which of the following is NOT an effect of excessive groundwater use?
(A) Land subsidence
(B) Lowering of the water table
(C) Increased streamflow in connected rivers
(D) Saltwater intrusion in coastal areas

158. The conservation of non-renewable resources is driven by the understanding that:
(A) They can be created artificially in laboratories.
(B) Their value will decrease over time.
(C) They are best left untouched and unused.
(D) They are finite and extraction has severe consequences.

159. Consider the following statements about natural hazards:
1. Earthquakes are caused by the sudden release of energy in the Earth's lithosphere.
2. Volcanism is exclusively an explosive and destructive process.
3. Floods can be caused by heavy rainfall, snowmelt, or dam failures.
4. Tsunamis are tidal waves caused by the gravitational pull of the moon.
Which of the above statement(s) is/are correct?
(A) 1 and 3 only
(B) 2 and 4 only
(C) 1, 2 and 3
(D) 1, 3 and 4

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160. Which of the following is a primary mitigation strategy for reducing earthquake risk to buildings?
(A) Painting the buildings in bright colors.
(B) Constructing buildings according to seismic design codes.
(C) Installing early warning sirens.
(D) Planting trees around the buildings.

161. What does the term plate tectonics refer to?
(A) The study of historical land plates and dishes.
(B) The process of mineral formation within the Earth's crust.
(C) Theory that Earth's outer shell is divided into moving plates.
(D) The chemical composition of tectonic plates.

162. The seasons on Earth are a consequence of:
(A) The variation in the Sun's heat output.

(D) Statement I is false but Statement II is true.

204. The term 'conservation' with respect to non-renewable resources primarily implies:
(A) Preventing all future use.
(B) Exporting the resource as quickly as possible.
(C) Ignoring the environmental impact of extraction.
(D) Using the resource wisely and efficiently to extend its availability.

205. Consider the following statements about natural hazards:
1. A landslide is a type of mass wasting.
2. A tsunami's wave height is greatest in the deep open ocean.
3. Volcanism can have both destructive and constructive effects on the landscape.
4. Prediction of earthquakes is now a precise and exact science.
5. An avalanche is a rapid flow of rock and debris.

Which of the above statement(s) is/are correct?
(A) 1 and 3
(B) 2 and 4
(C) 1, 3 and 5
(D) 2, 4 and 5

206. A key difference between a hazard and a disaster is that:
(A) A hazard is a natural event, while a disaster is the consequence of that event on a vulnerable population.
(B) A disaster is a natural event, while a hazard is the consequence.
(C) There is no difference; the terms are synonymous.
(D) A hazard is man-made, while a disaster is natural.

207. Which of the following is NOT a catastrophic geological hazard?
(A) Earthquake
(B) Gradual soil creep
(C) Volcanic eruption
(D) Tsunami

208. The formation of the Earth's core, mantle, and crust is a process known as:
(A) Photosynthesis
(B) Subduction
(C) Differentiation
(D) Accretion

209. The primary driver of the Indian monsoon is:
(A) The El Nino Southern Oscillation
(B) The Coriolis force at the equator
(C) The strength of the polar vortex
(D) The differential heating between the Asian landmass and the Indian Ocean

210. Which process involves the alteration of rocks by high temperature and pressure?
(A) Weathering
(B) Erosion
(C) Metamorphism
(D) Sedimentation

211. What is the fundamental cause of weathering?
(A) The movement of tectonic plates.
(B) Rocks and minerals seeking equilibrium with surface conditions.
(C) The generation of magma in the mantle.
(D) The radioactive decay of elements within rocks.

212. Which of the following best describes the Cation Exchange Capacity (CEC) of a soil?
(A) It is a measure of the soil's acidity or alkalinity.
(B) It is the ability of the soil to transmit water.
(C) It is the percentage of pore space in the soil.
(D) Negative charge capacity for holding nutrient cations.

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213. Read the following statements and select the correct option.
Statement I : Geochemical recycling involves only the movement of elements within the Earth's crust.
Statement II : The carbon cycle, involving the atmosphere, oceans, and biosphere, is a prime example of geochemical recycling.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

214. The Ghyben-Herzberg relation is most relevant for managing groundwater resources in which type of environment?

(A) Mountainous regions
(B) Arid deserts
(C) Coastal areas
(D) Glaciated landscapes

215. Consider the following statements regarding the exploration and exploitation of natural resources:
1. It can lead to significant environmental concerns like pollution and habitat destruction.
2. The concept of conservation of non-renewable resources arises from their finite nature.
3. Historical perspective shows a growing awareness of the need for sustainable management.
4. Exploitation of resources has no negative social impacts.

Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 3 and 4 only
(C) 1, 2 and 3
(D) 1, 2, 3 and 4

216. Which of the following geological hazards is driven primarily by gravity acting on a steep slope?
(A) Earthquake
(B) Landslide
(C) Volcanism
(D) Tsunami

217. The primary reason for the formation of large mountain ranges like the Himalayas is:
(A) The erosion by large rivers.
(B) A long history of volcanic eruptions.
(C) The collision of tectonic plates.
(D) The differential cooling of the Earth's crust.

218. In meteorology, what does the 'pressure gradient force' cause?
(A) It causes moving air to be deflected to the right in the Northern Hemisphere.
(B) It slows down wind speed near the Earth's surface.
(C) It is the force that holds the atmosphere to the Earth.
(D) It causes the initial movement of air from areas of high pressure to areas of low pressure.

219. A period of anomalously cool surface water temperatures in the central and eastern tropical Pacific is known as:
(A) La Nina
(B) El Nino
(C) A western disturbance
(D) The Indian Monsoon

220. The concept of residence time in a natural cycle can be calculated as:
(A) (Rate of input or output) / (Total amount of substance in the reservoir)
(B) (Total amount of substance in the reservoir) / (Rate of input or output)
(C) (Rate of input) x (Rate of output)
(D) (Total amount of substance) x (Age of the reservoir)

221. Which soil forming factor is most responsible for the differences between soils in a desert and soils in a tropical rainforest?
(A) Parent material
(B) Time
(C) Climate
(D) Relief

222. The process of 'deposition' in the sedimentary cycle is the:
(A) Chemical alteration of rock.
(B) Physical breakdown of rock.
(C) Transportation of rock fragments.
(D) Settling and accumulation of transported sediment.

223. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : Siderophile elements like iron and nickel are concentrated in the Earth's core.
Reason (R) : During primary geochemical differentiation, these dense, iron-loving elements sank towards the center of the planet.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

224. Which of the following is NOT a major groundwater province of India?
(A) Indo-Gangetic plains

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(B) Deccan Trap basaltic province
(C) The Sahara Desert province
(D) Himalayan mountainous region

225. Match the items in List I with those in List II and select the correct option.
List I (Term):
P. Darcy's Law
Q. Ghyben-Herzberg Relation
R. Cation Exchange Capacity
S. Plate Tectonics
List II (Associated Concept):
1. Soil fertility and chemistry
2. Formation of mountains and oceans
3. Freshwater-saltwater interface in coastal aquifers
4. Groundwater flow through porous media
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-1, S-4

226. Excessive withdrawal of groundwater can have all the following effects EXCEPT:
(A) Land subsidence
(B) Increased groundwater recharge rates
(C) Lowering of the water table
(D) Saltwater intrusion in coastal areas

227. The historical perspective on conservation of non-renewable resources has evolved towards:
(A) A 'use and discard' philosophy.
(B) A focus on sustainability, efficiency, and recycling.
(C) The belief that technology will always solve resource scarcity.
(D) Prioritizing extraction above all environmental concerns.

228. From the list below, which hazard is NOT a geological hazard?
(A) Wildfire
(B) Landslide
(C) Earthquake
(D) Volcanism

229. The ultimate goal of natural hazard mitigation is to:
(A) Stop natural processes from occurring.
(B) Reduce the vulnerability of society to the impacts of natural events.
(C) Accurately predict the exact time and place of all hazards.
(D) Provide financial compensation after a disaster.

230. The origin of the Earth's atmosphere is attributed to:
(A) The capture of interstellar gas and dust.
(B) The process of photosynthesis only.
(C) Outgassing of volatile compounds from the Earth's interior.
(D) The chemical weathering of crustal rocks.

231. Which of the following is the best description of a 'geophysical field'?
(A) A region on Earth where a specific type of rock is found.
(B) An area of land designated for geophysical research.
(C) The academic discipline of geophysics.
(D) A spatial physical quantity, such as gravity or magnetism.

232. Read the following statements and select the correct option.
Statement I : The rock cycle illustrates that any rock type can be transformed into any other rock type.
Statement II : The transformation processes in the rock cycle are driven by Earth's internal heat and external energy from the sun.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

233. The process of identifying and characterizing clay minerals is essential in soil science because:
(A) Clay minerals are the primary source of organic matter in soil.
(B) The color of the clay mineral is the only important property.
(C) Mineral types affect swelling, shrinking, and fertility.
(D) All clay minerals are identical, so their identification is a trivial exercise.

234. In geochemistry, the 'partitioning' of an element refers to its:
(A) Radioactive decay rate.
(B) Distribution or segregation between

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278. According to the passage, the validity of Darcy's Law may be limited in which of the following conditions?
(A) Very slow flow in fine-grained clay
(B) High-velocity flow in cavernous formations
(C) Areas with minimal groundwater fluctuations
(D) Aquifers with low hydraulic conductivity

279. What is the primary purpose of using groundwater tracers in hydro geology?
(A) To measure the hydraulic conductivity of an aquifer
(B) To determine the chemical composition of groundwater
(C) To track the movement and velocity of groundwater
(D) To purify groundwater for human consumption

280. The passage indicates that groundwater levels are dynamic and fluctuate primarily due to the balance between:
(A) Darcy's Law and its validity.
(B) hydrology and hydro geology.
(C) groundwater provinces and major basins.
(D) recharge and discharge.

Direction : Please read the following source carefully.

The over-extraction of groundwater resources leads to a range of severe environmental problems. One of the most significant effects of excessive groundwater use is the progressive lowering of the water table, which can cause wells to go dry and increase pumping costs. In some geological settings, this depletion of subsurface water can lead to land subsidence, a phenomenon where the ground level sinks as the pore spaces in the aquifer system compact after water is removed. This can cause extensive damage to infrastructure. Furthermore, the quality of remaining groundwater can be severely degraded. In coastal regions, the excessive pumping of freshwater can disrupt the natural balance between the freshwater lens and the underlying saline water. This relationship is described by the Ghyben-Herzberg relation, which indicates that for every unit of freshwater head above sea level, there is a much larger column of freshwater below sea level depressing the saltwater interface. Over-pumping reduces this head, causing the interface to rise and leading to saltwater intrusion, which contaminates the aquifer. This, combined with the general pollution of groundwater resources from surface contaminants, poses a grave threat to the sustainability of this vital water source.

Based on the above source, attempt the following five questions.

281. Land subsidence, as described in the passage, is a direct consequence of:
(A) compaction of aquifer materials after excessive water removal.
(B) the chemical pollution of groundwater.
(C) the natural fluctuation of the water table.
(D) saltwater intrusion in coastal aquifers.

282. The Ghyben-Herzberg relation is used to describe the relationship between:
(A) groundwater pollution and land subsidence.
(B) freshwater and saline water in coastal aquifers.
(C) pumping rates and the effects of excessive use.
(D) hydraulic conductivity and groundwater flow.

283. According to the Ghyben-Herzberg principle, what happens when excessive groundwater pumping reduces the freshwater head in a coastal aquifer?
(A) The rate of land subsidence decreases.
(B) The saline water interface rises, contaminating the freshwater.
(C) The overall groundwater quality improves.
(D) The hydraulic conductivity of the aquifer increases.

284. Which of the following is identified as an immediate effect of the excessive use of groundwater?
(A) A lowering of the groundwater table
(B) An increase in the validity of Darcy's Law
(C) A decrease in the risk of land subsidence
(D) An increase in the rate of natural recharge

285. The passage highlights two major threats to groundwater quality: pollution from surface sources and which other process?
(A) Land subsidence
(B) Aquifer compaction

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(D) Isotope geochemistry

244. What is the primary reason for the validity of Darcy's Law being restricted to laminar flow?
(A) Turbulent flow only occurs in non-porous media.
(B) Darcy's Law does not account for fluid viscosity.
(C) Laminar flow is a theoretical concept that does not exist in nature.
(D) Turbulent flow rate relations become non-linear.

245. From a resource management perspective, why is the conservation of non-renewable resources like copper and zinc important?
(A) Because they are essential for biological processes.
(B) Because they are sources of renewable energy.
(C) Because they are finite, and their formation takes geological timescales.
(D) Because their price is always constant.

246. What is the most common cause of avalanches?
(A) Earthquakes
(B) A rapid accumulation of new snow on an existing weak snow layer.
(C) Volcanic eruptions melting snowpack.
(D) Strong winds blowing snow off ridges.

247. The impact of a natural hazard is a function of the hazard itself and the _____ of the population exposed to it.
(A) size
(B) wealth
(C) age
(D) vulnerability

248. The distinction between a mineral and a rock is that:
(A) A rock is an aggregate of one or more minerals.
(B) A mineral is a solid, while a rock is a liquid.
(C) A mineral has economic value, while a rock does not.
(D) A rock is naturally occurring, but a mineral is man-made.

249. Which of the following is the best example of geochemical recycling on a long time scale?
(A) The daily cycle of photosynthesis and respiration.
(B) The subduction of oceanic crust and its subsequent melting and volcanism.
(C) The seasonal growth and decay of plants.
(D) The evaporation and precipitation of water.

250. Read the following statements and select the correct option.
Statement I : Mitigation of natural hazards aims to eliminate the hazard itself.
Statement II : Mitigation aims to reduce the negative impacts and consequences of a hazard event.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

Direction : Please read the following source carefully.

The origin of Earth is intrinsically linked to its primary geochemical differentiation, a fundamental process that established its layered structure. Following its formation, the planet underwent a period of intense heating, causing it to become largely molten. In this state, gravity drove the segregation of materials based on their density. Heavier elements, predominantly iron and nickel, sank towards the center to form the dense, metallic core. Lighter, silicate-rich materials floated upwards, eventually cooling and solidifying to form the primitive mantle and crust. This large-scale partitioning of elements was not confined to the solid Earth; it also led to the formation of the planet's fluid spheres. Through a process of volcanic outgassing, volatile compounds trapped within the planet's interior were released. These gases, including water vaper, carbon dioxide, and nitrogen, accumulated to form the primordial atmosphere. As the Earth continued to cool, this water vapor condensed and precipitated, collecting in basins on the crust to form the hydrosphere. This sequence of differentiation—from a homogenous body to a stratified planet with a core, mantle, crust, atmosphere, and hydrosphere—laid the foundational framework for all subsequent geological and environmental processes.

Based on the above source, attempt the following five questions.

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251. Which process was the primary driver for the geochemical differentiation of the early Earth into its core, mantle, and crust?
(A) Magnetic field generation
(B) Gravitational segregation by density
(C) Radioactive decay in the crust
(D) Volcanic outgassing of volatiles

252. According to the passage, the Earth's primordial atmosphere was formed primarily through which mechanism?
(A) Release of trapped gases from the interior
(B) Condensation of interplanetary dust
(C) Photosynthesis by early life forms
(D) Chemical reactions in the hydrosphere

253. What is the correct sequence of formation for Earth's major layers as described in the process of geochemical differentiation?
(A) Atmosphere, Core, Mantle, Hydrosphere
(B) Crust, Mantle, Core, Atmosphere
(C) Core, Mantle, Crust, Atmosphere
(D) Mantle, Hydrosphere, Crust, Core

254. The formation of the hydrosphere was a direct consequence of which of the following events?
(A) The sinking of heavy elements to form the core
(B) The establishment of a permanent magnetic field
(C) The initial accretion of the planet from solar nebula materials
(D) The cooling of the planet and condensation of atmospheric water vapor

255. The passage suggests that the primary compositional difference between the Earth's core and its crust is that the core is predominantly _____, while the crust is _____-rich.
(A) gaseous; volatile
(B) silicate; metallic
(C) metallic; silicate
(D) volatile; silicate

Direction : Please read the following source carefully.

The movement of air in the Earth's atmosphere is governed by a complex interplay of forces. The primary instigator of air motion is the pressure gradient force, which directs air from areas of high pressure to areas of low pressure. However, this movement does not follow a straight path due to the Earth's rotation, which generates the Coriolis force. This apparent deflective force acts perpendicular to the direction of motion, turning moving air to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. In the upper atmosphere, where friction is negligible, a balance between the pressure gradient force and the Coriolis force results in a geostrophic wind field, where winds blow parallel to isobars. Closer to the Earth's surface, the frictional force becomes significant, acting to slow the wind and disrupt this balance. The inclusion of friction, along with the pressure gradient and Coriolis forces, leads to the formation of gradient wind, which flows around curved pressure centers. Understanding these fundamental forces—pressure gradient, Coriolis, and frictional—is essential for interpreting atmospheric circulation patterns and weather systems, including the Earth's thermal environment and the distribution of its seasons.

Based on the above source, attempt the following five questions.

256. Which force is responsible for initiating the movement of air from one place to another?
(A) Coriolis force
(B) Pressure gradient force
(C) Frictional force
(D) Geostrophic force

257. A geostrophic wind field is characterized by a balance between which two forces?
(A) Frictional force and Coriolis force
(B) Pressure gradient force and frictional force
(C) Gravitational force and pressure gradient force
(D) Pressure gradient force and Coriolis force

258. The primary effect of the Coriolis force is to:
(A) deflect the path of moving air.
(B) increase the speed of the wind.
(C) initiate the movement of air.
(D) slow the wind near the Earth's surface.

259. According to the passage, the influence of the frictional force is most significant in which part of the atmosphere?
(A) In the upper atmosphere where geostrophic winds dominate
(B) Equally at all altitudes from the surface to

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the stratosphere
(C) Closer to the Earth's surface
(D) Only in the Southern Hemisphere

260. The concept of gradient wind is used to describe air flow that incorporates which combination of forces?
(A) Pressure gradient force, Coriolis force, and frictional force
(B) Pressure gradient force and Coriolis force only
(C) Coriolis force and frictional force only
(D) Pressure gradient force and frictional force only

Direction : Please read the following source carefully.

The climates of India are dominated by the monsoon, a large-scale seasonal reversal of winds that brings the majority of the country's annual rainfall. This system is influenced by a variety of regional and global phenomena. During the winter months, western disturbances, which are extratropical storms originating in the Mediterranean region, travel eastward and bring crucial moisture and precipitation to the northern parts of the subcontinent. The performance of the primary summer monsoon is significantly modulated by large-scale ocean-atmosphere interactions, most notably the El Niño-Southern Oscillation (ENSO). The El Niño phase is often associated with weakened monsoon rainfall and can lead to severe droughts across India. Conversely, the La Niña phase typically correlates with enhanced monsoon rainfall, sometimes resulting in floods. These phenomena highlight the interconnectedness of the global climate system, where conditions in the Pacific Ocean can have profound impacts on India's water resources and agricultural productivity. The variability in these climatic patterns, from the timing of western disturbances to the strength of the monsoon, defines the environmental rhythm of the region and poses significant challenges for water and food security.

Based on the above source, attempt the following five questions.

261. What is the defining characteristic of the Indian monsoon as described in the passage?
(A) Its association with El Niño
(B) The occurrence of western disturbances
(C) Its origin in the Mediterranean region
(D) A seasonal reversal of wind direction

262. Western disturbances are described as phenomena that primarily affect India during which season?
(A) Summer
(B) Winter
(C) Post-monsoon
(D) Monsoon onset

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263. According to the passage, the El Niño phenomenon is most commonly associated with which impact on the Indian monsoon?
(A) Enhanced rainfall and potential flooding
(B) Earlier onset of the monsoon season
(C) Weakened rainfall and potential drought
(D) Increased frequency of western disturbances

264. The La Niña phase is presented as having an effect on the Indian monsoon that is generally:
(A) identical to that of El Niño.
(B) negligible compared to western disturbances.
(C) limited to the southern parts of India.
(D) opposite to that of El Niño.

265. Based on the passage, the variability of which climatic factors presents a major challenge to India's water and food security?
(A) The strength of the monsoon and timing of western disturbances
(B) Only the strength of El Niño events
(C) The predictable and regular pattern of monsoons
(D) The consistency of the geostrophic wind field

Direction : Please read the following source carefully.

The formation of soil is a complex process initiated by the weathering of parent rocks. Weathering encompasses the in-situ breakdown of rocks and minerals at the Earth's surface through various physical and chemical reactions. The resultant fragmented material, or sediment, is then subjected to erosion, transportation, and deposition by agents like water, wind, and ice. This deposited material forms the parent material upon which soil develops. The process of soil formation,

ocean waves that can inundate coastal areas. Another distinct hazard is the cloud burst, an extreme rainfall event in a short period over a localized area, which can trigger flash floods and landslides. Understanding the geological origins and mechanisms of these diverse hazards is the first step towards assessing risk and developing effective mitigation strategies.

Based on the above source, attempt the following five questions.

291. According to the passage, catastrophic geological hazards are generally characterized by:
(A) low magnitude and high frequency.
(B) predictable timing and low impact.
(C) high magnitude and low frequency.
(D) human-induced origins.

292. Which natural hazard is described as being generated by the displacement of a large volume of water, often due to a submarine earthquake?
(A) Tsunami
(B) Landslide
(C) Avalanche
(D) Cloud burst

293. The primary cause of earthquakes, as stated in the passage, is:
(A) the eruption of volcanoes.
(B) the rapid flow of snow down a slope.
(C) an extreme rainfall event in a localized area.
(D) the sudden release of accumulated tectonic stress.

294. A cloud burst is defined in the passage as which type of event?
(A) A landslide triggered by an earthquake
(B) An extreme and localized rainfall event
(C) A sudden eruption of volcanic ash
(D) A series of powerful ocean waves

295. The passage links the occurrence of landslides to which potential triggers?
(A) Volcanic eruptions and tsunamis
(B) Avalanches and cloud bursts
(C) Heavy rainfall and seismic activity
(D) Tectonic stress release and volcanism

Direction : Please read the following source carefully.

Responding effectively to natural hazards requires a two-pronged approach involving prediction and mitigation. The prediction of hazards involves forecasting their occurrence, location, and magnitude. For some hazards, such as floods, which can be anticipated by monitoring river levels and meteorological conditions, or tsunamis, for which early warning systems can be activated following a submarine earthquake, prediction capabilities are relatively advanced. However, for other catastrophic geological hazards, notably earthquakes, precise short-term prediction remains a significant scientific challenge. Given these limitations in prediction, the mitigation of impacts becomes critically important. Mitigation refers to actions taken to reduce or eliminate the long-term risk to human life and property from natural hazards. These measures can be structural, such as constructing earthquake-resistant buildings or building seawalls to protect against tsunamis, or non-structural, such as developing land-use zoning regulations to prevent construction in high-risk areas, implementing building codes, and raising public awareness. The ultimate goal of mitigation is to create more resilient communities that are less vulnerable to the destructive impacts of inevitable natural hazard events.

Based on the above source, attempt the following five questions.

296. According to the passage, what is the fundamental difference between prediction and mitigation?
(A) Prediction is a structural measure, while mitigation is a non-structural measure.
(B) Prediction is only for earthquakes, while mitigation is for floods and tsunamis.
(C) Prediction is a societal response, while mitigation is a scientific response.
(D) Prediction aims to forecast an event, while mitigation aims to reduce its impact.

297. The passage suggests that the scientific ability to predict which of the following hazards is currently the most limited?
(A) Earthquakes
(B) Floods
(C) Tsunamis
(D) Hurricanes

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271. What is the concept of partitioning as it relates to surficial geologic processes?
(A) The equal distribution of elements across all Earth spheres.
(B) The geochemical classification of elements based on atomic weight.
(C) The differential distribution and concentration of elements between solid and fluid phases.
(D) The decay of radioactive elements to form stable daughter products.

272. According to the passage, the geochemical recycling of elements describes the:
(A) permanent storage of elements within the Earth's crust.
(B) movement of elements between the Earth's different reservoirs.
(C) classification of elements into different geochemical groups.
(D) study of element abundance in the bulk Earth only.

273. The passage suggests that the abundance of a specific element is:
(A) uniform throughout the crust, hydrosphere, and biosphere.
(B) highest in the biosphere for all elements.
(C) constant and unchanging over geological time.
(D) variable depending on the specific Earth reservoir being considered.

274. An understanding of element partitioning and geochemical recycling is identified as being important for the study of:
(A) paleoclimate.
(B) geostrophic wind fields.
(C) plate tectonics.
(D) the origin of the Earth's core.

275. Surficial geologic processes such as weathering and sedimentation directly contribute to:
(A) the formation of the Earth's core.
(B) the generation of the Coriolis force.
(C) the geochemical partitioning of elements.
(D) the uniform mixing of all elements in the hydrosphere.

Direction : Please read the following source carefully.

The study of water on Earth, known as hydrology, and specifically groundwater, termed hydrogeology, is critical for resource management. Water is distributed unevenly across the planet, with a significant portion stored underground in aquifers. In India, these groundwater resources are organized into major basins and groundwater provinces, each with distinct geological characteristics. The fundamental principle governing the movement of groundwater through porous media is Darcy's Law. This law states that the flow rate is proportional to the hydraulic gradient and the hydraulic conductivity of the material. Hydraulic conductivity is a key parameter representing the ease with which water can move through pore spaces or fractures in an aquifer. However, Darcy's law has limits to its validity, particularly in very high-velocity or turbulent flow regimes, such as in cavernous limestone. The volume of groundwater in storage is not static; it exhibits fluctuations in response to recharge from precipitation and discharge from pumping or natural springs. To better understand groundwater flow paths and velocities, hydrogeologists often employ groundwater tracers, which are substances added to the water that can be tracked as they move through the subsurface system.

Based on the above source, attempt the following five questions.

276. Darcy's Law establishes a proportional relationship between groundwater flow rate and which two factors?
(A) Hydraulic gradient and hydraulic conductivity
(B) Groundwater fluctuations and water temperature
(C) Groundwater tracers and aquifer depth
(D) Water density and basin size

277. The term hydraulic conductivity refers to:
(A) the total volume of water in a groundwater province.
(B) the chemical quality of the groundwater.
(C) the seasonal fluctuation of the water table.
(D) the ease with which water can move through a porous medium.

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different coexisting phases, like melt and crystals.
(C) Total abundance in the bulk Earth.
(D) Industrial application and use.

235. Consider the following reservoirs of freshwater on Earth:
1. Groundwater
2. Ice caps and glaciers
3. Lakes and rivers

Which of the following represents the correct order in decreasing order of volume?
(A) 1, 2, 3
(B) 2, 1, 3
(C) 3, 1, 2
(D) 2, 3, 1

236. Hydraulic conductivity is a key parameter in hydrogeology that quantifies the:
(A) Total volume of water an aquifer can hold.
(B) Pressure in a confined aquifer.
(C) Fluctuation of the water table over time.
(D) Ease with which water can move through a porous medium.

237. Which of the following is a direct consequence of land subsidence due to groundwater withdrawal in a coastal city?
(A) Increased risk of flooding from storm surges and high tides.
(B) Decreased risk of flooding from storm surges.
(C) Improvement in groundwater quality.
(D) A rise in the elevation of the city.

238. The following question consists of two statements—Assertion (A) and Reason (R).
Assertion (A) : The prediction of natural hazards like floods and cyclones has improved significantly.
Reason (R) : Advances in remote sensing, computer modeling, and monitoring networks allow for better tracking and forecasting of hazardous conditions.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

239. The formation of extrusive igneous rocks, like basalt, is associated with:
(A) The slow cooling of magma deep within the crust.
(B) The rapid cooling of lava on the Earth's surface.
(C) The compaction and cementation of sand.
(D) The intense pressure and heat on limestone.

240. Consider the following statements about forces on the atmosphere:
1. The pressure gradient force drives air from high to low pressure.
2. The Coriolis force deflects moving air due to Earth's rotation.
3. The frictional force is strongest at high altitudes.
4. A geostrophic wind is a balance between pressure gradient and Coriolis forces.
5. The Coriolis force is zero at the poles.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3
(B) 1, 2 and 4
(C) 2, 3, 4 and 5
(D) 1, 2, 4 and 5

241. What is the fundamental difference between weathering and erosion?
(A) Weathering involves water, while erosion involves wind.
(B) Weathering is a chemical process, while erosion is a physical process.
(C) There is no difference; the terms are interchangeable.
(D) Weathering is rock breakdown; erosion is the transport.

242. The high cation exchange capacity of a soil is generally considered beneficial for agriculture because:
(A) It indicates the soil can retain and supply more essential plant nutrients.
(B) It means the soil has poor drainage.
(C) It means the soil is highly acidic.
(D) It prevents water from infiltrating the soil.

243. The study of tree rings to reconstruct past climates is known as:
(A) Palynology
(B) Geochronology
(C) Dendroclimatology

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(C) Saltwater intrusion
(D) Increased pumping costs

Direction : Please read the following source carefully.

The management of natural resources involves a complex balance between their exploration, exploitation, and conservation. From a historical perspective, the use of resources has often prioritized short-term economic gains, particularly in the case of non-renewable resources like minerals and fossil fuels. This approach, centered on exploration to locate new deposits and exploitation to extract them, has fueled industrial development but has also given rise to significant environmental concerns. These concerns include habitat destruction, pollution of air and water, and landscape degradation associated with mining and extraction activities. Recognizing that non-renewable resources are finite and cannot be replenished on human time scales, the focus has increasingly shifted towards conservation. Conservation does not necessarily mean non-use, but rather the wise, efficient, and sustainable use of these resources to ensure their availability for future generations. This involves strategies such as reducing consumption, recycling materials, and developing alternatives. Thus, a modern approach to resource management must integrate the historical lessons of unchecked exploitation with a forward-looking commitment to conservation and mitigating the environmental impacts of resource use.

Based on the above source, attempt the following five questions.

286. According to the passage, the historical perspective on resource use has often prioritized:
(A) long-term environmental sustainability.
(B) conservation of non-renewable resources.
(C) the development of renewable alternatives.
(D) short-term economic gains from exploitation.

287. The primary reason for the growing emphasis on the conservation of non-renewable resources is that they are:
(A) associated with major environmental concerns.
(B) difficult to explore and locate.
(C) finite and cannot be replenished on human time scales.
(D) unevenly distributed across the globe.

288. Which of the following is identified in the passage as a significant environmental concern related to resource exploitation?
(A) Decreased economic development
(B) Pollution and habitat destruction
(C) Depletion of renewable resources
(D) An increase in resource exploration costs

289. The concept of conservation, as presented in the passage, is best described as:
(A) the complete cessation of resource use.
(B) focusing exploration only on renewable resources.
(C) the historical approach to resource management.
(D) the wise and sustainable use of resources.

290. The passage suggests that a modern approach to natural resource management should:
(A) integrate exploitation with conservation and environmental mitigation.
(B) ignore the historical perspective of exploitation.
(C) focus exclusively on exploring new deposits.
(D) prioritize the exploitation of non-renewable over renewable resources.

Direction : Please read the following source carefully.

The Earth's surface is subject to a variety of natural hazards, among which catastrophic geological hazards are particularly significant due to their potential for widespread devastation. These events, often characterized by high magnitude and low frequency, originate from geological processes. Earthquakes, for instance, are the result of a sudden release of accumulated stress along tectonic plate boundaries or faults. Volcanism involves the eruption of molten rock, ash, and gases from a magma chamber beneath the Earth's surface. Landslides represent the rapid down-slope movement of rock, soil, and debris, often triggered by heavy rainfall or seismic activity. In mountainous or cold regions, an avalanche, the swift flow of snow down a slope, poses a major threat. Submarine earthquakes or volcanic eruptions can displace vast amounts of water, generating a tsunami, a series of powerful

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or pedogenesis, involves the transformation of this parent material through the influence of climate, organisms, relief, and time. A crucial component of soil is its mineral content, particularly the soil-forming minerals that dictate its properties. Clay minerals, for instance, are critical in controlling the soil's physical and chemical characteristics. One such vital property is the Cation Exchange Capacity (CEC), which is a measure of the soil's ability to hold and exchange positively charged ions (cations). The CEC is strongly governed by the type and amount of clay minerals present, as their layered structures and surface charges provide sites for cation adsorption. Therefore, mineralogical controls, established through weathering and soil formation processes, are fundamental to soil fertility and health.

Based on the above source, attempt the following five questions.

266. What is the fundamental difference between weathering and erosion as described in the passage?
(A) Weathering is a chemical process, while erosion is a physical process.
(B) Weathering is an in-situ breakdown, while erosion involves movement.
(C) Weathering forms clay minerals, while erosion forms sand.
(D) Weathering occurs on the surface, while erosion occurs underground.

267. The Cation Exchange Capacity (CEC) of a soil is primarily controlled by its:
(A) color and texture.
(B) mineralogical composition, especially clay minerals.
(C) depth and parent material.
(D) rate of erosion and transportation.

268. According to the passage, the process of soil formation directly begins with:
(A) the deposition of weathered parent material.
(B) the establishment of Cation Exchange Capacity.
(C) the chemical reaction of clay minerals.
(D) the transportation of sediments by wind.

269. The passage implies that a soil with a high content of certain clay minerals would likely have:
(A) a low Cation Exchange Capacity.
(B) no ability to hold cations.
(C) a high Cation Exchange Capacity.
(D) a composition devoid of soil-forming minerals.

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270. Which of the following best represents the sequence of events leading to the development of soil properties?
(A) Erosion -> Transportation -> Deposition -> Weathering
(B) Deposition -> Cation Exchange -> Soil Formation -> Weathering
(C) Soil Formation -> Weathering -> Clay Mineral Identification
(D) Weathering -> Erosion/Transportation/ Deposition -> Soil Formation

Direction : Please read the following source carefully.

The field of geochemistry involves the study of the distribution and abundance of chemical elements within the Earth's various spheres. Elements can be grouped according to a geochemical classification system that reflects their typical affinities and behaviors. Their abundance varies significantly across different reservoirs, such as the bulk Earth, the crust, the hydrosphere, and the biosphere. During surficial geologic processes like weathering, erosion, and sedimentation, a phenomenon known as partitioning occurs. Partitioning refers to the differential distribution of elements, where certain elements are preferentially enriched in the solid phase (minerals) while others are mobilized and concentrated in the fluid phase (water). This process is fundamental to the formation of many mineral deposits and the chemical evolution of surface waters. Over geological timescales, elements are not permanently locked in one reservoir but are moved between the crust, hydrosphere, atmosphere, and biosphere through various physical, chemical, and biological pathways. This movement constitutes the geochemical recycling of elements, a continuous process that is crucial for maintaining the planet's habitability. Understanding these cycles and the partitioning behavior of elements is also vital for interpreting the paleoclimate records preserved in sediments and ice cores.

Based on the above source, attempt the following five questions.

298. Constructing a seawall to protect a coastal community from a tsunami is an example of which type of measure?
(A) A non-structural mitigation measure
(B) A structural mitigation measure
(C) A hazard prediction technique
(D) A public awareness campaign

299. Which of the following is described as a non-structural mitigation strategy?
(A) Building earthquake-resistant infrastructure
(B) Implementing land-use zoning regulations
(C) Activating an early warning system
(D) Monitoring river levels for flood forecasting

300. What is the ultimate goal of mitigation as described in the passage?
(A) To reduce the vulnerability and risk from hazard impacts.
(B) To achieve perfect prediction for all natural hazards.
(C) To prevent natural hazards from ever occurring.
(D) To relocate all populations away from high-risk areas.

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Cation Exchange Capacity serves as a critical indicator of soil fertility by measuring the ability of soil to hold positively charged nutrients. This property is primarily determined by the presence of clay minerals and organic matter, which possess net negative surface charges. These negative sites attract and temporarily store essential cations like calcium and potassium, preventing them from leaching away and ensuring they remain available.

18. (A) Weathering
The breakdown of rocks and minerals through contact with atmospheric elements, water, and living organisms is defined as weathering. This process can be mechanical, involving physical disintegration, or chemical, involving the alteration of mineral structures. Unlike erosion, which focuses on the movement and transport of materials, weathering is an in-situ process that prepares the Earth's surface for subsequent transport and the eventual formation of soil.

19. (B) 1, 3, 4 and 5
Soil development is a complex function of climate, topography, biological activity, and time. Climate dictates the rates of chemical and physical reactions, while relief influences drainage and erosion patterns. Biological organisms contribute organic matter and facilitate nutrient cycling. Crucially, the parent rock significantly influences the initial chemical properties of the soil. Since these processes are exceptionally slow, time remains a vital factor in achieving a mature soil profile.

20. (D) Feldspar
Feldspar is among the most abundant mineral groups in the Earth's crust and serves as a primary source for secondary minerals. Through the process of chemical weathering, specifically hydrolysis, feldspar crystals break down and release ions, eventually reorganizing into various types of clay minerals. This transformation is a fundamental step in pedogenesis, influencing the physical and chemical properties of the resulting soil, including its texture and fertility.

21. (B) P-2, Q-4, R-1, S-3
Soil science involves several key parameters that define the physical and chemical nature of the Earth's surface layer. Texture describes the specific proportions of sand, silt, and clay, while structure refers to how these particles aggregate into clumps. The cation exchange capacity measures the ability to store vital nutrients, and horizons represent the distinct horizontal layers formed over time. Understanding these descriptions is essential for evaluating soil health.

22. (B) Erosion
Erosion is the geological process characterized by the physical removal and transport of weathered rock fragments and soil from one location to another. This movement is driven by natural agents such as flowing water, wind, moving ice, or the pull of gravity. While weathering breaks down the material in place, erosion actively reshapes the landscape by stripping away surface layers and transporting sediments to distant basins.

23. (B) Both Statement I and Statement II are false.
Soil formation is an exceptionally slow geological process that typically requires hundreds to thousands of years to produce a mature profile. Furthermore, the chemical composition of soil is deeply influenced by the local climate, as temperature and precipitation determine the rates of mineral weathering and nutrient leaching. Therefore, claiming that soil develops rapidly or that its chemistry is independent of climatic conditions is factually incorrect and ignores fundamental principles.

24. (A) Hydrolysis
Hydrolysis is a primary chemical weathering process where water molecules react directly with silicate minerals to form new mineral products, such as clay. During this reaction, hydrogen ions from the water displace metal cations in the mineral lattice, leading to the chemical breakdown of the original rock. This process is distinct from mechanical actions like frost wedging or abrasion, as it fundamentally changes the chemical identity of materials.

25. (A) 1 and 2 only
Soil properties are categorized into physical and chemical groups that determine its behavior and utility. Physical traits include texture, which reflects particle size distribution, and porosity, while chemical traits include pH levels and cation exchange capacity. It is a misconception

is directed parallel to lines of constant pressure, effectively explaining the movement of high-altitude weather systems.

9. (C) The average duration a substance spends in a reservoir.
In environmental and geological sciences, residence time quantifies the average period a specific substance or element remains within a particular reservoir, such as the atmosphere or oceans. This value is determined by dividing the total capacity of the reservoir by the rate at which the substance enters or leaves it. Understanding this duration is essential for modeling the turnover rates and concentrations of materials in cycles.

10. (A) 1 and 2 only
The Earth is structured into several layers with distinct physical states and compositions. The outermost solid layer is the crust, followed by the mantle, which extends to the core-mantle boundary. It is essential to recognize that while the inner core is solid due to intense pressure, the outer core is liquid. Furthermore, the core is mainly composed of metallic iron and nickel rather than lighter silicate mineral compounds found above.

11. (D) Heat, pressure, and chemically active fluids
Metamorphism involves the solid-state transformation of existing sedimentary, igneous, or other metamorphic rocks into new forms. This transition is driven by exposure to extreme thermal energy, high lithostatic or directed pressure, and the presence of chemically active fluids. These agents facilitate the recrystallization of minerals and the development of new textures without melting the rock, leading to the creation of unique geological structures and compositions.

12. (B) The differential heating and cooling of land and sea.
The seasonal reversal of winds known as the Indian monsoon is fundamentally driven by the unequal heating of the vast Asian landmass compared to the surrounding Indian Ocean. During summer, the land warms rapidly, creating a low-pressure zone that draws in moist air from the cooler sea. This cycle reverses in winter as the land cools faster than the water, establishing a large-scale atmospheric circulation pattern.

13. (D) Steady state
A steady state characterizes a system where variables remain constant over time because the influx of matter or energy exactly balances the outflux. This dynamic equilibrium ensures that despite continuous internal movement or processing, the overall properties and concentrations within the system do not experience a net change. This concept is vital in environmental science for evaluating the stability of natural cycles and various complex ecological systems.

14. (A) 2, 3, 4, 1
The formation of the Earth followed a logical sequence beginning with the accretion of solid particles from the solar nebula to form a proto-planet. This was followed by primary differentiation as heat caused dense materials to sink, creating the core. Once the layers stabilized, the crust solidified upon cooling. Finally, internal outgassing and volcanic activity released the volatile gases and water necessary to build the atmosphere and hydrosphere.

15. (A) El Nino
El Nino is a significant climate phenomenon characterized by the unusual warming of surface waters in the eastern tropical Pacific Ocean. This event disrupts normal atmospheric circulation patterns, often leading to heavy rainfall in South America and severe droughts in parts of Asia and Australia. It represents the warm phase of the El Nino-Southern Oscillation cycle, having profound impacts on global weather patterns and marine ecosystems.

16. (B) Weathering processes only occur in hot and humid tropical climates.
Weathering is a universal geological process that occurs across all climatic zones, from frozen polar regions to arid deserts. While the intensity and specific type of weathering, such as chemical or mechanical, vary with temperature and moisture, no environment is entirely immune to rock decay. Suggesting that these processes are restricted only to hot and humid tropical climates ignores the significant roles of frost action and wind.

17. (A) Both A and R are true and R is the correct explanation of A.

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in ice significantly exceeds the volumes found in aquifers, rivers, lakes, and the atmosphere combined, making it the primary freshwater reservoir.

34. (B) 1, 2 and 3
The hydrosphere encompasses all forms of water on Earth, including liquid oceans, solid ice caps, and gaseous atmospheric vapor. The vast majority of this water is saline, found primarily in the oceans. Regarding freshwater, the volume stored underground in aquifers far exceeds the amount present in all surface lakes and rivers combined. It is important to note that the total water volume on Earth remains relatively constant through the hydrological cycle.

35. (C) Flow rate is proportional to area, conductivity, and gradient.
Darcy's Law is a fundamental equation in hydro geology that describes the flow of fluid through a porous medium like an aquifer. It establishes that the flow rate is directly proportional to the cross-sectional area through which the water moves, the hydraulic conductivity of the material, and the hydraulic gradient. This relationship allows scientists to calculate how quickly and in what direction groundwater will move based on the physical properties of the soil.

36. (D) The Indo-Ganga-Brahmaputra plains
The Indo-Ganga-Brahmaputra plains represent one of the most significant groundwater provinces in India due to their extensive and thick sequences of alluvial sediments. These deposits create highly productive aquifers that store vast quantities of freshwater, supporting the agricultural needs of a large population. Unlike the hard rock terrains of the Deccan or the Aravallis, these plains offer high porosity and permeability, making them ideal for large-scale groundwater extraction.

37. (A) P-3, Q-1, R-4, S-2
Hydro geology relies on specific terms to describe the storage and movement of water beneath the surface. An aquifer is a permeable formation that stores and transmits water, whereas an aquitard is a low-permeability layer that restricts movement. Hydraulic conductivity quantifies the ease of water transmission through a medium. Finally, groundwater fluctuation refers to the rise and fall of the water table caused by seasonal recharge patterns or human extraction activities.

38. (B) Excessive withdrawal of groundwater.
Land subsidence occurs when the ground surface sinks due to the removal of support from the subsurface. In many regions, the excessive withdrawal of groundwater from aquifers reduces the fluid pressure within the pore spaces of sediments. This loss of pressure causes the sediment layers to compact and settle, leading to a permanent lowering of the land surface. This phenomenon is a serious environmental consequence of unsustainable water management in urban and agricultural areas.

39. (D) The relationship between fresh and saline groundwater in coastal aquifers.
The Ghyben-Herzberg relation is a principle used to model the equilibrium between fresh and saline groundwater in coastal aquifers. Because freshwater is slightly less dense than saltwater, it floats as a lens on top of the underlying marine water. This relation provides a mathematical way to estimate the depth of the interface between these two water types, which is crucial for preventing saltwater intrusion during the pumping of coastal wells.

40. (D) Statement I is false but Statement II is true.
Darcy's Law is primarily applicable to laminar flow conditions, where water moves slowly and smoothly through the small pores of a medium. In cases of high velocity or turbulent flow, the linear relationship between flow rate and gradient no longer holds. However, hydraulic conductivity is correctly defined as a property that depends on both the physical characteristics of the porous medium, such as grain size, and the properties of the fluid.

41. (C) To determine the velocity and flow path of groundwater.
Groundwater tracers are substances introduced into an aquifer to monitor the movement of water. By tracking the appearance of these tracers at different locations, hydrologists can accurately determine the velocity of the flow and the specific paths the water takes through the subsurface. This information is vital for modeling the spread of contaminants, understanding recharge zones,

that dark color always indicates superior fertility or that tropical and polar soils are identical. Soil characteristics are highly diverse and depend on complex interactions between various factors.

26. (A) Magmatic crystallization
Pedogenesis involves the transformation of parent material through the addition of organic matter, the leaching of soluble minerals, and the chemical alteration of original minerals into secondary forms like clay. Magmatic crystallization, however, is the process of forming igneous rocks from cooling molten material, which occurs deep within the crust or at volcanic sites. This process creates the rock that may eventually weather into soil but is not soil formation.

27. (D) Lithophile
According to the Goldschmidt classification system, elements are grouped based on their chemical affinities during the Earth's differentiation. Lithophile elements possess a strong affinity for oxygen and are predominantly concentrated in the silicate minerals of the crust and mantle. These elements, which include silicon, aluminum, and magnesium, contrast with those that prefer metallic iron or sulfide phases, thus defining the primary chemical composition of the Earth's rocky layers.

28. (B) Oxygen
Oxygen is the most abundant element in the Earth's crust, accounting for nearly half of its total mass. This high abundance exists because oxygen readily forms strong chemical bonds with other common elements, such as silicon and aluminum, to create the silicate minerals that constitute the majority of crustal rocks. While iron is more prevalent in the bulk Earth due to the core, oxygen dominates the chemistry of the surface.

29. (C) A is true but R is false.
Paleoclimatology utilizes indirect evidence, known as proxy data, to reconstruct the Earth's climate history before the advent of modern technology. Sources like ice cores, tree rings, and sediment layers provide vital clues about past temperatures and atmospheric conditions. This reliance is necessary because direct instrumental records, such as thermometer readings, have only been available for a very small fraction of the planet's multi-billion-year history, making long-term direct observations impossible.

30. (D) The segregation and concentration of elements into distinct phases.
The partitioning of elements refers to the non-uniform distribution and segregation of chemical components into different phases or environments during geological processes. On the Earth's surface, factors such as solubility, adsorption, and biological uptake cause elements to concentrate in specific areas, such as soils, seawater, or mineral deposits. This process prevents elements from being evenly distributed, leading to the diverse chemical variations observed in different rocks and environmental reservoirs.

31. (A) Carbon movement between the atmosphere, oceans, and biosphere.
Geochemical recycling describes the continuous movement and transformation of elements as they circulate through the atmosphere, hydrosphere, lithosphere, and biosphere. The carbon cycle is a quintessential example, showing how carbon moves between the air, oceans, and living organisms. This process ensures that essential elements are reused and redistributed across the planet over various time scales, maintaining the balance necessary for geological stability and the continued existence of life.

32. (B) Siderophile (iron-loving)
The Goldschmidt classification categorizes elements based on their preferred chemical environment. Siderophile elements, often referred to as iron-loving, have a high affinity for metallic iron and tend to dissolve in it. During the early differentiation of the Earth, these dense elements sank along with molten iron to form the planet's core. Consequently, elements like nickel and cobalt are primarily found in the core rather than the silicate-rich crust or mantle.

33. (B) Glaciers and ice caps
While the Earth's surface is mostly covered by water, only a small fraction is fresh. Among these freshwater sources, glaciers and permanent ice caps hold the largest volume, primarily located in Antarctica and Greenland. Although groundwater is the largest source of accessible liquid freshwater, the total amount of water frozen

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ANSWERS

1. (B) Sorting of elements by density to form the core, mantle, and crust.
Primary geochemical differentiation describes the transformation of the early proto-Earth from a relatively homogenous body into a layered planet with distinct chemical and physical zones. This fundamental process occurred as heavy, dense elements like iron and nickel migrated toward the center to form the core, while lighter silicate materials rose to create the mantle and crust. This density-driven stratification established the Earth's basic internal structural framework.

2. (C) Statement I is true but Statement II is false.
The Coriolis force is a pseudo-force appearing in rotating reference frames, deflecting moving objects like air currents without changing their speed. While this force significantly alters wind direction, it cannot initiate motion from rest. The initial movement of air is triggered by differences in atmospheric pressure across distances. Consequently, the first assertion regarding the nature of the force is accurate, while the second assertion remains incorrect.

3. (C) Crust - Composed mainly of liquid magma
The Earth's crust is characterized as the outermost solid shell, primarily consisting of solid silicate rocks rather than liquid magma. While molten material exists in the mantle and outer core, the crust remains rigid and cool enough to maintain a solid state. Identifying this layer as liquid magma is incorrect because the crust provides the stable, solid platform necessary for geological formations and biological life on our planet.

4. (D) Pressure gradient force
Air movement is primarily initiated by differences in atmospheric pressure between two distinct geographic locations. This pressure imbalance creates a force that pushes air from areas of high pressure toward areas of low pressure to achieve equilibrium. While other factors like the rotation of the planet or friction affect the final path and speed of the wind, the initial motive force for wind creation is always the pressure gradient.

5. (A) P-3, Q-4, R-1, S-2
Earth systems are defined by various physical and geological principles that maintain global dynamics. Differentiation involves the separation of the planet into compositional layers, while plate tectonics explains the movement of the lithosphere. The energy budget describes the equilibrium of incoming and outgoing radiation essential for climate stability. Finally, a steady state refers to a system condition where properties remain constant because inputs and outputs are balanced.

6. (B) The Earth's magnetic field
Landforms are primarily shaped by internal tectonic forces, external climatic processes, and volcanic activity that redistribute matter across the Earth's surface. While the magnetic field is vital for protecting the atmosphere from solar radiation and influencing core dynamics, it does not exert a direct physical control on the sculpting or creation of geological features. Surface morphology remains largely independent of the orientation or strength of the magnetic poles.

7. (D) The cooling and solidification of molten magma or lava.
Igneous rocks originate from the process of crystallization as molten material loses heat. When magma cools deep beneath the surface or lava solidifies upon reaching the exterior, mineral crystals begin to form and interlock, resulting in a solid rock mass. This transition from a high-energy liquid state to a lower-energy solid state distinguishes igneous formations from those created by sedimentation or the alteration of existing rocks.

8. (A) Both A and R are true and R is the correct explanation of A.
The geostrophic wind represents a theoretical model where the horizontal pressure gradient force and the Coriolis force reach an exact balance. This equilibrium typically occurs in the upper atmosphere where the effects of surface friction are negligible. Because these two forces act in opposite directions, the resulting air flow

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and managing water resources, rather than serving to purify the water or increase its storage.

42. (C) 1, 2, 3 and 5
Groundwater contamination is categorized by its origin and nature. Point source pollution, such as leaks from underground tanks, comes from a single identifiable location. Conversely, non-point source pollution arises from diffuse areas, such as agricultural runoff spreading fertilizers across fields. Additionally, some contamination occurs naturally due to the dissolution of minerals from geological formations, such as arsenic. Understanding these distinctions is essential for effective environmental monitoring and the implementation of remediation strategies.

43. (D) Land degradation and water pollution
The extraction and utilization of non-renewable resources like coal present significant environmental challenges. Mining operations often lead to severe land degradation, destroying local ecosystems and habitats. Furthermore, these activities can cause extensive water pollution through the discharge of mine drainage and the leaching of heavy metals. These impacts contrast with renewable energy goals, as coal exploitation typically degrades air quality and disrupts natural hydrological cycles rather than enhancing biodiversity or groundwater recharge.

44. (B) The realization that resources are finite and require judicious use.
A historical perspective on resource conservation highlights the realization that Earth's mineral and energy supplies are finite. As societies have evolved, there has been an increasing awareness that unchecked extraction leads to depletion and environmental damage. This viewpoint emphasizes the need for judicious and sustainable use of resources to ensure their availability for future generations. It rejects the idea of limitless consumption, advocating for management strategies that balance economic needs with environmental stewardship.

45. (C) Soil erosion
Catastrophic geological hazards are sudden, high-energy events that can cause widespread destruction and loss of life within a very short timeframe. Earthquakes, volcanic eruptions, and tsunamis fit this definition due to their violent nature and immediate impact. In contrast, soil erosion is generally a gradual, long-term process occurring over years or decades. While it is an environmental concern, its slow pace prevents it from being classified as a sudden catastrophic event like a tectonic disaster.

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46. (D) To reduce the loss of life and property by lessening impacts.
Hazard mitigation focuses on long-term strategies and actions taken to reduce or eliminate the risks associated with natural disasters. The primary objective is to minimize the potential loss of life and property damage by lessening the impacts of an event. This is achieved through measures such as implementing strict building codes, improved land-use planning, and public education. Mitigation does not aim to prevent the natural phenomenon itself, but rather to increase societal resilience.

47. (A) 2, 3, 1
Natural hazards vary significantly in their speed of onset. Earthquakes occur almost instantaneously with virtually no warning, representing the fastest onset. Landslides can happen very quickly but are often preceded by rainfall or ground movement, placing them second. Droughts, however, are slow-onset hazards that develop gradually over months or even years as a result of prolonged precipitation deficiency. Therefore, the sequence from fastest to slowest is earthquake, followed by landslide, and then drought.

48. (B) Cloud burst
A cloud burst is a highly localized and extreme weather event characterized by exceptionally heavy rainfall occurring in a very short duration. This sudden deluge often leads to flash floods, especially in mountainous regions where the terrain funnels water into narrow valleys. Unlike the broader seasonal patterns of the monsoon or the steady rain from western disturbances, a cloud burst is a violent and concentrated outburst that can cause immediate and severe hydrological disasters.

49. (B) Large-scale underwater earthquakes at subduction zones.
Tsunamis are large-scale ocean waves primarily generated by the sudden displacement of water following underwater geological disturbances.

The most common cause is a powerful submarine earthquake, particularly at subduction zones where one tectonic plate slides beneath another. This vertical movement of the seafloor pushes the water column above it, creating waves that travel across the ocean. Other causes can include submarine landslides or volcanic eruptions, but tectonic plate movement remains the dominant trigger.

50. (A) Both A and R are true and R is the correct explanation of A.
Precisely predicting the exact timing, location, and magnitude of a major earthquake remains a significant scientific challenge. This difficulty arises because the geological processes occurring deep within the crust involve complex, non-linear, and often chaotic interactions between tectonic plates and fault systems. While scientists can identify high-risk zones and estimate long-term probabilities, the inherent complexity of these deep-seated movements prevents the type of accurate, short-term forecasting possible with weather-related events.

51. (B) Input equals output, maintaining a dynamic balance.
A steady state in an Earth system refers to a condition of dynamic balance where the properties of the system remain unchanged over time. This occurs when the rate of input for matter or energy is exactly equal to the rate of output. Unlike a static system, a steady state involves continuous movement and transformation, but the overall levels and concentrations remain stable. This concept is essential for understanding how natural cycles maintain equilibrium despite constant flux.

52. (A) The tilt of the Earth's rotational axis with respect to its orbital plane.
The progression of seasons on Earth is primarily caused by the 23.5-degree tilt of the planet's rotational axis relative to its orbital path around the Sun. As Earth orbits, different hemispheres receive varying amounts of direct solar radiation and experience different day lengths at different times of the year. This axial orientation, combined with the annual revolution, creates the predictable seasonal changes in temperature and weather, rather than the changing distance between the Earth and Sun.

53. (C) 1, 2 and 3
The gradient wind is a theoretical model of air flow that accounts for movement along curved isobars. This type of wind occurs when there is a three-way balance between the pressure gradient force, the Coriolis force, and the centrifugal force arising from the curved trajectory. In the lower atmosphere, the frictional force also plays a significant role in modifying wind speed and direction. Therefore, the actual movement of air involves the interaction of all these forces.

54. (D) Mediterranean Sea
Western disturbances are extratropical storms that originate in the Mediterranean region and travel eastward across the Middle East before reaching the Indian subcontinent. These systems are driven by the westerly jet stream and are crucial for providing essential winter precipitation to northwestern India and Pakistan. The moisture for these storms is primarily picked up from the Mediterranean Sea, distinguishing them from the summer monsoons that draw moisture from the nearby Indian Ocean and Arabian Sea.

55. (B) P-4, Q-2, R-1, S-3
Global climate and weather are influenced by several interconnected phenomena. El Nino is marked by the warming of the eastern tropical Pacific, while La Nina represents a corresponding cooling phase. The Indian Monsoon is defined by a seasonal shift in wind direction that brings heavy rainfall. Conversely, a drought is a prolonged period of insufficient precipitation. Correctly matching these phenomena with their primary characteristics is essential for understanding atmospheric dynamics and regional climate variations.

56. (B) Primary differentiation was driven by material density.
The Earth's initial formation involved the assembly of material that was originally a homogenous mixture. However, heat from accretion and radioactive decay allowed for primary geochemical differentiation. This process was fundamentally driven by the density of materials; dense metals like iron sank to the center to form the core, while lighter silicate materials rose to form the mantle and crust. This density-based sorting established the planet's

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internal structure and preceded the development of the atmosphere.

57. (D) Near the Earth's surface, especially over rough terrain.
Friction is a force that opposes motion and significantly influences wind speed and direction near the Earth's surface. Its impact is most pronounced within the planetary boundary layer, extending up to about one kilometer. The magnitude of this force depends on surface roughness; it is much stronger over complex land terrains with mountains and forests than over smooth ocean surfaces. At higher altitudes, the air moves more freely as the effects of surface friction diminish.

58. (A) Both Statement I and Statement II are true.
The Earth's surface is shaped by a continuous interaction between internal and external processes. Plate tectonic activity serves as a primary control by creating large-scale features like mountains, trenches, and volcanic islands through crustal movements. Simultaneously, climatic processes such as glaciation, river flow, and wind act as external agents that weather, erode, and sculpt these tectonic forms. Both statements are accurate, highlighting how landforms result from the dynamic interplay of these fundamental geological and atmospheric forces.

59. (C) The Earth's biological field.
Geophysical fields refer to regions where specific physical forces or quantities, such as gravity, magnetism, or heat, can be measured across the Earth. These fields are fundamental to understanding the planet's internal structure and dynamics. While the Earth's gravitational, magnetic, and thermal fields are standard geophysical concepts, there is no such thing as a biological field in this context. Biology relates to the biosphere, which interacts with these fields but does not constitute a geophysical field itself.

60. (B) 1, 3 and 4
The rock cycle describes the continuous transformation of rocks between igneous, sedimentary, and metamorphic types. Igneous rocks form from cooling magma, which can occur deep underground as intrusive rocks or on the surface as extrusive volcanic rocks. Sedimentary rocks arise from the lithification of weathered fragments. Crucially, metamorphic rocks form from existing rocks through heat and pressure without melting; if they were to melt completely, they would become magma and eventually form igneous rocks.

61. (D) The climate of the region.
Climate is considered the most dominant factor in soil formation because it determines the speed and nature of chemical and physical weathering. Temperature and precipitation levels directly influence the rates of mineral breakdown, the accumulation of organic matter, and the leaching of nutrients. While parent rock and topography are important, the over arching influence of climate ensures that regions with similar weather patterns often develop similar soil types, regardless of their specific geographic longitude or local magnetic fields.

62. (B) Salinization
Salinization is a process in which water-soluble salts, such as sodium chloride and calcium sulfate, accumulate within the soil profile. This often occurs in arid or semi-arid regions where high evaporation rates draw moisture upward, leaving salts behind, or through poor irrigation practices. Excessive salt concentrations are detrimental to soil health as they inhibit plant growth and reduce overall fertility, eventually leading to land degradation and a significant decline in agricultural productivity across affected landscapes.

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63. (C) Smectite (e.g., Montmorillonite)
Smectite is a group of clay minerals, including montmorillonite, characterized by a significant capacity to expand when wet and shrink when dry. This high shrink-swell potential is caused by water molecules entering the spaces between the mineral layers. In construction, these expansive clays can cause severe damage to foundations, roads, and other structures as the soil volume changes with moisture. This property distinguishes smectite from more stable clay minerals like kaolinite or illite found in other soils.

64. (A) Both A and R are true and R is the correct explanation of A.

Tropical rainforests are paradoxically characterized by lush vegetation growing on nutrient-poor soils. This occurs because the consistent high temperatures and heavy rainfall accelerate the process of chemical weathering and leaching. Essential nutrients are rapidly washed out of the topsoil and carried away by groundwater. The vegetation survives primarily through the extremely efficient and rapid recycling of nutrients from decaying organic matter on the forest floor, rather than by drawing from a rich mineral soil reservoir.

65. (A) Frost action is a form of chemical weathering.
Weathering is divided into physical and chemical categories based on whether the mineral composition changes. Processes like oxidation, carbonation, and hydrolysis involve chemical reactions that alter the rock's chemistry. Biological activity can contribute to both, such as roots prying rocks apart or organisms releasing acids. However, frost action, or frost wedging, is a purely physical process where the expansion of freezing water exerts pressure to break rocks apart without changing their underlying chemical structure or mineral identity.

66. (B) Cation Exchange Capacity (CEC)
Cation Exchange Capacity is a fundamental chemical property of soil that quantifies its ability to attract, hold, and exchange positively charged ions, or cations. This capacity is primarily provided by the negative surface charges on clay minerals and organic matter. Soils with a high value can store significant amounts of essential nutrients like calcium, magnesium, and potassium, preventing them from being leached away by rainfall and making them available for plant uptake over time, ensuring long-term soil health.

67. (C) Subduction of tectonic plates beneath the soil.
Soil formation, or pedogenesis, is driven by four basic processes: additions of organic and mineral materials, losses through leaching or erosion, transformations of minerals and organic matter, and translocations of these materials within the soil profile. These processes occur at or near the Earth's surface. In contrast, the subduction of tectonic plates is a large-scale internal geological process that occurs deep within the Earth and does not contribute to the immediate formation or development of soil layers.

68. (D) Sand, silt, and clay
Soil texture is a fundamental physical property defined by the relative proportions of three distinct sizes of mineral particles: sand, silt, and clay. Sand particles are the largest and provide good drainage, while clay particles are the smallest and have high water and nutrient retention. Silt particles fall between these two in size. By measuring the percentage of each component, scientists can classify soil types into categories like loam, sandy clay, or silty loam, which determines soil utility.

69. (D) Statement I is false but Statement II is true.
While parent material provides the initial mineral source for soil, it is not the sole or even the primary determinant of a soil's final properties. Soil development is a dynamic process influenced by a combination of factors, including climate, biological organisms, topography, and the passage of time. These active factors can significantly alter the parent material, leading to vastly different soil types even if the original rock was the same. Thus, the second statement is the correct one.

70. (B) Deposition
In the geological cycle of surface materials, weathered rock fragments are first loosened by weathering and then removed by erosion. These particles are subsequently moved to new locations through various modes of transportation, such as wind or flowing water. The final stage occurs when the energy of the transporting agent decreases, causing the material to settle and accumulate in a new location. This settling process is known as deposition, which eventually leads to the formation of sedimentary layers.

71. (C) 1, 2, 3 and 5
Soil mineralogy involves both primary and secondary minerals. Clay minerals are secondary products of weathering and are vital for properties like nutrient retention and soil plasticity. Quartz is a primary mineral that is extremely resistant to weathering, making it a common component of sandy soils. Identifying specific clay minerals often requires advanced techniques like X-ray diffraction. However, it is incorrect to assume all

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soils consist entirely of clay, as they also contain sand, silt, and organic matter.

72. (D) Are found predominantly as gases in the atmosphere and hydrosphere.
In the Goldschmidt classification of elements, the term Atmophile refers to elements that are gas-loving. These elements have a low affinity for both silicate minerals and metallic phases, leading them to concentrate primarily in the Earth's atmosphere and hydrosphere. Common examples include nitrogen and noble gases like argon. This classification system helps geochemists understand how different elements were distributed among the Earth's various layers and reservoirs during its early differentiation and subsequent multi-billion-year geological history.

73. (A) Paleoclimatology
Paleoclimatology is the specialized branch of science dedicated to the study and reconstruction of the Earth's past climates. Researchers in this field analyze data from various natural archives, such as ice cores, tree rings, coral reefs, and deep-sea sediment layers. These records provide indirect evidence of historical temperatures, precipitation levels, and atmospheric compositions. This work is essential for understanding long-term climate variability and provides a historical context for evaluating modern climate change trends and future environmental projections.

74. (C) Iron
When considering the entire Earth rather than just its crust, iron is the most abundant element by mass. This is because iron is the primary constituent of the Earth's massive core, which accounts for a significant portion of the planet's total weight. While oxygen and silicon are highly prevalent in the crust and mantle, the concentrated presence of metallic iron in the center makes it the dominant element in the bulk composition of the planet when all layers are considered.

75. (A) P-3, Q-4, R-1, S-2
The Goldschmidt classification groups elements based on their chemical behavior and affinity during the Earth's formation. Lithophile elements like silicon associate with silicates, while siderophiles like iron prefer metallic phases. Chalcophile elements, such as copper, have an affinity for sulfur and are typically found in sulfide ores. Finally, atmophile elements like nitrogen are predominantly found in the atmosphere. This system effectively explains the distribution of elements across the different layers and reservoirs of our planet during geological history.

76. (B) Adsorption onto clay particles in soil.
The partitioning of lead during surface processes often involves its movement and concentration within soil environments. Due to its chemical properties, lead ions can be strongly adsorbed onto the surfaces of clay particles and organic matter. This process prevents the lead from being evenly distributed, instead concentrating it within specific soil horizons. Adsorption is a key mechanism of partitioning, as it segregates elements based on their affinity for solid surfaces versus remaining in a dissolved state within groundwater.

77. (D) Real-time satellite temperature data
Paleoclimate studies rely on proxy data, which are indirect records of past conditions preserved in natural materials. Common proxies include isotopic ratios in ice, the thickness of tree rings, and preserved pollen in sediments. These sources allow scientists to look back thousands or millions of years. In contrast, real-time satellite temperature data provide direct, modern instrumental measurements. Since satellites have only existed for a few decades, they cannot serve as a proxy for ancient geological climates from previous eras.

78. (A) Phosphorus does not have a significant gaseous phase in its cycle.
The geochemical cycle of phosphorus is unique because it lacks a significant gaseous phase in the atmosphere. Unlike carbon or nitrogen, which move through the air as carbon dioxide or nitrogen gas, phosphorus remains primarily in solid and liquid forms. It circulates through rocks, water, soil, and living organisms. This absence of an atmospheric component makes the phosphorus cycle much slower and more dependent on geological processes like weathering and sedimentation to move through the environment over time.

79. (D) Statement I is false but Statement II is true.

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the need for economic development with the preservation of environmental health. This is achieved through strategies like reducing waste, increasing efficiency, and protecting ecosystems. True conservation does not mean stopping all use, but rather using resources wisely to avoid rapid depletion and severe environmental degradation.

138. (D) Earthquake
The Richter scale and the more modern Moment Magnitude Scale are used to quantify the magnitude of earthquakes. These scales measure the amount of energy released during a seismic event based on the amplitude of seismic waves recorded by seismographs. Unlike intensity scales that describe the damage observed on the surface, magnitude scales provide a standard way to compare the size of earthquakes regardless of location. This measurement is vital for seismic research and for designing earthquake-resistant buildings and critical infrastructure.

139. (C) Statement I is true but Statement II is false.
Predicting avalanches is a complex process that involves evaluating the stability of the snowpack, current and forecasted weather patterns, and the specific terrain of a mountain slope. While experts can identify high-risk conditions and issue warnings to prevent disasters, it is not possible to predict the exact moment or size of an avalanche with perfect accuracy, especially weeks in advance. Natural systems involve too many variables for such precise long-term forecasting, making continuous monitoring and short-term assessment essential for safety.

140. (D) A destructive mudflow or debris flow on the slopes of a volcano.
A lahar is a specific type of natural hazard consisting of a destructive mudflow or debris flow that originates on the slopes of a volcano. These flows are typically triggered when volcanic activity melts snow and ice on the summit or when heavy rainfall mixes with loose volcanic ash and debris. Lahars can travel at very high speeds down river valleys, burying everything in their path. They represent a significant risk to communities living near volcanoes, even those far from eruptions.

141. (C) Gravitational forces
The primary geochemical differentiation of the Earth was a process driven by gravity during the planet's early, molten stage. Gravitational forces pulled denser materials, particularly metallic iron and nickel, toward the center to form the core. Simultaneously, lighter silicate-rich materials were pushed outward, eventually solidifying to form the mantle and the crust. This density-based stratification established the fundamental internal structure of the planet, separating the Earth into its primary chemical layers based on the mass and buoyancy of elements.

142. (A) A state of minimum energy and maximum stability that the system tends towards over time.
Equilibrium in an Earth system refers to a state of minimum energy where the system reaches its most stable configuration over time. When a system is in equilibrium, there is no net tendency for change unless external conditions are altered. This concept is different from a steady state, as it implies a long-term stabilization where physical and chemical processes have balanced out. Understanding equilibrium is essential for predicting how geological systems respond to disturbances and how they evolve over long periods.

143. (B) 3, 1, 4, 2
The rock cycle describes the continuous transformation of Earth materials. Starting with a sedimentary rock, a logical progression involves exposing the rock to intense heat and pressure to undergo metamorphism. If temperatures continue to rise, the rock may melt into magma. Upon cooling, this magma will solidify into a new igneous rock. Eventually, that igneous rock can be weathered and eroded back into sediments, starting the cycle anew. This sequence demonstrates the interconnected ness of all rock types through geological processes.

144. (D) At the North Pole
The Coriolis force is an effect of the Earth's rotation that deflects moving objects like air and water. The strength of this force is highly dependent on latitude; it is zero at the equator and increases as one moves toward the poles. This occurs because the rotational velocity of the Earth changes most rapidly relative to the axis at higher latitudes. Therefore, the Coriolis effect is strongest at the North and South Poles, where

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flow easily, which is a characteristic of productive aquifers like sand or gravel.

87. (A) Conservation of non-renewables - Promoting indefinite use
Conservation of non-renewable resources is fundamentally based on the understanding that these materials are finite and cannot be replaced once consumed. Therefore, a strategy that promotes indefinite or unchecked use is the opposite of conservation. Effective management involves reducing waste, recycling materials, and finding sustainable alternatives to extend the lifespan of available resources. Identifying this incorrect pairing highlights the core principle of resource stewardship, which prioritizes judicious use and long-term sustainability over rapid and short-term exploitation.

88. (C) The contribution to anthropogenic climate change through greenhouse gas emissions.
The exploitation of fossil fuels such as coal, oil, and natural gas has profound long-term environmental impacts. The most significant concern is the release of carbon dioxide and other greenhouse gases into the atmosphere during combustion. These emissions are the primary drivers of anthropogenic climate change, leading to rising global temperatures, melting glaciers, and shifting weather patterns. While mining causes local land and water issues, the cumulative effect on the global climate represents the most far-reaching environmental challenge.

89. (A) The movement of rock, debris, or earth down a sloped section of land.
A landslide is a geological phenomenon involving the downslope movement of a mass of rock, debris, or earth under the direct influence of gravity. This process, a form of mass wasting, can be triggered by various factors, including heavy rainfall, earthquakes, or human activities that destabilize slopes. Landslides vary in speed and scale, but they all share the common characteristic of material moving down an inclined surface, distinguishing them from other hazards like floods or seismic shaking.

90. (A) 1, 2, 3, 4
The development of a major flood typically follows a specific sequence. It begins with intense or prolonged rainfall that delivers more water than the soil can absorb. Once the soil becomes saturated, surface runoff increases significantly, causing the river's water level to rise. If the discharge exceeds the river's bankfull capacity, the water spills over the banks and inundates the adjacent floodplain. This chronological progression explains how atmospheric conditions translate into a destructive hydrological hazard for the region.

91. (B) Acid rain
Catastrophic geological hazards are characterized by their sudden occurrence and potential for immediate, large-scale destruction. Events such as volcanic eruptions, earthquakes, and avalanches fit this description because they involve rapid releases of energy or material that can cause instant devastation. In contrast, acid rain is a form of environmental pollution that develops gradually over time due to chemical emissions. While it causes significant ecological and structural damage, its slow onset and non-violent nature exclude it from being a catastrophic hazard.

92. (C) Ground deformation, seismicity, and gas emissions.
Volcanic eruption prediction has significantly improved through the continuous monitoring of precursor activities. Scientists track changes in seismicity, as moving magma creates distinct earthquake patterns. They also measure ground deformation using tiltmeters and satellites, which indicate the swelling of the volcano as pressure builds. Additionally, monitoring the types and amounts of gas emissions, such as sulfur dioxide, provides vital clues about the state of the magma. These combined observations allow for more reliable early warning systems and evacuations.

93. (C) Statement I is true but Statement II is false.
Mitigation strategies for landslides focus on engineering solutions to increase slope stability, such as building retaining walls and improving drainage to prevent water saturation. While these measures are effective at reducing risk, the precise prediction of exactly when a landslide will occur remains extremely difficult. Many factors, including soil moisture and internal friction, interact in complex ways, meaning that while high-risk areas can be identified, short-term forecasting is not yet highly accurate or reliable.

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The Indian summer monsoon is a large-scale weather pattern characterized by the movement of moist, warm air from the sea toward the land. This occurs because the Asian landmass heats up significantly during the summer, creating a low-pressure zone that draws in air from the high-pressure area over the cooler Indian Ocean. As this moisture-laden air rises over the land and mountains, it cools and releases heavy precipitation, which is vital for the region's agriculture and overall water supply.

124. (D) A naturally occurring solid with definite composition and structure.
A mineral is defined as a naturally occurring, inorganic solid that possesses a definite chemical composition and a highly ordered internal atomic structure. Unlike rocks, which are aggregates of multiple minerals, a mineral is a single, homogenous substance. This definition excludes man-made materials and liquids. Minerals form through geological processes such as crystallization from magma or precipitation from water. Understanding these properties is essential for identifying different mineral species and for studying the composition and history of the Earth's crust.

125. (B) P-2, Q-4, R-1, S-3
Weathering processes are categorized into physical and chemical types. Frost wedging is a physical process where the freezing and thawing of water breaks rocks apart. Chemical processes include oxidation, where minerals react with oxygen to form oxides, and carbonation, involving reactions with carbonic acid that are common in limestone. Hydrolysis is the chemical reaction between minerals and water. Correctly identifying these processes is vital for understanding how rocks disintegrate and transform into soil and other sediments across different environmental conditions.

126. (D) Sediments
Sediments are the loose, fine-grained materials produced by the weathering and erosion of rocks. These fragments can be transported by agents such as wind, flowing water, or moving ice across the Earth's surface. Once the energy of the transporting agent decreases, the sediments are deposited in new locations, where they can eventually accumulate in thick layers. Over geological time, these accumulated sediments may undergo compaction and cementation to form sedimentary rocks, completing an important phase of the rock cycle.

127. (A) Cation Exchange Capacity (CEC)
Cation Exchange Capacity is the soil property with the most significant influence on its ability to hold and supply essential nutrients to plants. This capacity arises from the negative electrical charges found on the surfaces of clay minerals and organic matter. These sites attract and store positively charged ions like calcium, magnesium, and potassium. Soils with a high value act as a nutrient reservoir, preventing these vital elements from leaching away and ensuring they remain available for biological uptake over time.

128. (C) Relief (topography)
The CLORPT acronym summarizes the five primary factors that control soil formation: Climate, Organisms, Relief, Parent material, and Time. In this context, R stands for Relief, which refers to the topography or physical shape of the landscape. Relief influences soil development by affecting drainage patterns, the rate of erosion, and the amount of sunlight and moisture a particular area receives. Steep slopes often have thinner soils, while flat areas may accumulate thicker, more moisture-rich soil profiles over time.

129. (A) They have layered structures and net negative charges.
Clay minerals are secondary minerals formed through the chemical weathering of primary minerals like feldspar. They are characterized by their microscopic, layered crystal structures and typically carry a net negative electrical charge. These properties are essential for soil behavior, as the negative charge allows them to hold onto positively charged nutrients and water molecules. Unlike sand-sized particles, clay minerals are extremely small and play a dominant role in determining soil plasticity, fertility, and overall water retention capacity.

130. (A) 1, 2 and 3
Geochemical cycles describe the continuous movement and recycling of chemical elements through Earth's atmosphere, hydrosphere, lithosphere, and biosphere. This recycling is

that remove it are very slow. Understanding these durations helps scientists predict the long-term impact of pollutants or the stability of natural chemical cycles.

102. (B) The soil's capacity to hold and supply nutrient cations like Ca^{2+}, Mg^{2+}, and K^{+}.
Cation Exchange Capacity is a critical soil property that measures the total capacity of a soil to hold exchangeable cations. These cations, such as calcium, magnesium, and potassium, are essential plant nutrients. Soil particles like clay and organic matter have negative charges that attract and hold these positively charged ions. A higher capacity means the soil can store more nutrients and supply them to plants over time, which is a major factor in determining overall soil fertility and health.

103. (A) Both A and R are true and R is the correct explanation of A.
Chemical weathering involves reactions that alter the mineral composition of rocks. The rate of these reactions is highly sensitive to environmental conditions. High temperatures provide the energy needed to speed up chemical processes, while abundant water serves as a medium and a reactant for hydrolysis and oxidation. Therefore, in hot and humid climates, rocks break down much faster than in cold or arid regions. Both the assertion and the reason are true, with the reason correctly explaining the acceleration.

104. (A) Weathering, Erosion, Transportation, Deposition
The lifecycle of sediments follows a specific chronological sequence. It begins with weathering, the in-situ breakdown of rock into smaller fragments. Once the material is loosened, erosion involves the physical removal of these pieces from their original site. Transportation follows, where agents like water or wind move the sediments across distances. Finally, when the energy of the transporting agent is no longer sufficient to carry the material, deposition occurs, allowing the sediments to settle and eventually form new layers.

105. (B) 2 and 3
Soil is a complex medium formed through the interaction of various factors. Climate is a dominant control, as it dictates the speed of weathering and the type of soil that develops. Soil formation results from a combination of physical, chemical, and biological processes working together over time. However, physical properties refer to texture and structure rather than mineral chemistry. Furthermore, clay minerals are identified by their structure and charge, and nutrient capacity is primarily controlled by clay and organic matter.

106. (B) A complex and slow process involving weathering and transformation.
Soil formation, or pedogenesis, is not a simple or rapid event. It is a complex and extremely slow process that takes hundreds to thousands of years to produce a mature profile. It involves the physical and chemical weathering of parent rock, the addition and decomposition of organic matter by organisms, and the reorganization of these materials into distinct layers. This transformation requires the continuous interaction of climate, topography, and life, making it a sophisticated geological and biological phenomenon rather than a simple accumulation.

107. (C) Magma
Soil is composed of weathered mineral fragments and organic matter. Minerals like feldspar, mica, and quartz are common primary constituents of the rocks that break down to form the mineral fraction of soil. Feldspar and mica often weather into clay, while quartz remains as sand. Magma, however, is molten rock found deep underground or erupting at the surface. While it solidifies to form the rocks that eventually weather, magma itself is not a mineral or a component of soil.

108. (D) The process of primary geochemical differentiation.
The chemical composition of the Earth's crust differs significantly from the planet's overall bulk composition due to primary geochemical differentiation. During the early, molten stage of Earth's history, gravity caused dense materials like iron and nickel to sink toward the center to form the core. Simultaneously, lighter elements and silicate-rich materials rose to the surface, eventually solidifying into the crust and mantle. This density-driven separation concentrated specific elements in the outer layers, while others were sequestered deep within the planet.

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109. (C) The climate of a past period in the Earth's history.
Paleoclimate refers to the atmospheric and environmental conditions that existed during past periods of the Earth's multi-billion-year history. Because direct instrumental records only exist for the very recent past, scientists reconstruct these ancient climates using proxy data from sources like glaciers, tree rings, and fossil records. Studying paleoclimate is essential for understanding the natural range of climate variability and for providing a historical context that helps improve modern climate models and predict future environmental changes.

110. (B) Chalcophile
In the Goldschmidt classification system, elements are grouped based on their chemical preferences. Chalcophile elements, often called ore-loving, have a low affinity for oxygen but a high affinity for sulfur. Consequently, they tend to concentrate in sulfide minerals and ores rather than in the silicate rocks of the crust or the metallic iron of the core. Elements like copper, zinc, and lead are classic examples of chalcophiles, playing a vital role in the formation of important economic mineral deposits.

111. (D) The tracer moves with groundwater to track velocity.
Groundwater tracers are substances that are added to an aquifer to help scientists understand its internal dynamics. The fundamental principle is that these tracers move along with the groundwater as it flows through the subsurface. By measuring how long it takes for a tracer to travel from an injection point to a monitoring well, hydrologists can accurately calculate the groundwater's velocity and map its flow path. This method is essential for studying the movement of water and the potential spread of pollutants.

112. (A) Both Statement I and II are true; II explains I.
The excessive extraction of fresh groundwater in coastal regions can lead to the serious issue of saltwater intrusion. The Ghyben-Herzberg relation provides the scientific basis for this phenomenon, showing that fresh and saline water exist in a delicate density-driven balance. When the freshwater table is lowered due to over-pumping, the pressure it exerts decreases, allowing the denser saline water from the ocean to move further inland and upward into the aquifer. Both statements are true, with the second explaining the first.

113. (C) Water movement, distribution, and management on Earth.
Hydrology is the scientific discipline dedicated to the study of water on Earth, encompassing its movement, distribution, and overall management. It covers the entire water cycle, including precipitation, surface runoff, groundwater flow, and evaporation. Hydrologists examine how water interacts with both the physical environment and human society, focusing on maintaining water quality and ensuring sustainable use. This field is distinct from geophysics, as it specifically prioritizes the liquid, solid, and gaseous forms of water across the planet's reservoirs.

114. (D) The Peninsular Shield (including parts of the Deccan)
The Peninsular Shield, which covers a large portion of central and southern India, is a major groundwater province characterized by hard, crystalline rock formations like granite and basalt. Unlike the porous alluvial sediments of the Gangetic plains, these rocks have very low primary porosity. Groundwater in these regions is primarily stored and transmitted through secondary features like fractures, joints, and weathered zones. This geological setting makes groundwater extraction more challenging and less productive compared to the vast alluvial basins in the north.

115. (A) Sustainable management through recycling and substitution is necessary.
A historical perspective on non-renewable resources reveals that they are finite and their extraction often entails significant environmental costs. Over time, societies have recognized that unchecked consumption is unsustainable. This understanding leads to the conclusion that resource management must prioritize sustainability through strategies like recycling, increasing efficiency, and developing technological substitutes. Judicious use is necessary to ensure these essential materials remain available for future generations, balancing modern economic progress with the reality of

finite mineral and energy supplies provided by the Earth.

116. (B) Earthquake
Earthquakes are natural hazards that originate directly from tectonic processes within the Earth's crust and upper mantle. They occur when accumulated stress along fault lines is suddenly released, causing the ground to shake. While floods, droughts, and cloud bursts are significant hazards, they are atmospheric or hydrological in origin, driven by weather patterns and precipitation. Earthquakes, along with volcanic activity and tsunamis, represent the primary hazards caused by the dynamic movement and interaction of the Earth's large-scale tectonic plates.

117. (C) Hurricanes (Cyclones)
Among various natural hazards, the prediction of hurricanes and tropical cyclones has seen the most significant success. Advances in satellite technology, radar, and computer modeling allow meteorologists to track these storms and forecast their paths and intensities with high accuracy several days in advance. This capability provides essential time for coastal communities to implement evacuation plans and secure property. In contrast, predicting the exact timing of earthquakes or landslides remains far more difficult due to the complex subsurface processes involved.

118. (B) An intense hurricane
Tsunamis are powerful ocean waves generated by the sudden displacement of a large volume of water. This displacement is usually caused by vertical geological events such as submarine earthquakes, large landslides falling into the sea, or volcanic eruptions. While intense hurricanes can cause significant storm surges and high waves, they do not displace the entire water column in the same way that tectonic or mass wasting events do. Therefore, a hurricane is the least likely of these options to generate a true tsunami.

119. (A) 3, 4, 2, 1
The Earth is composed of several layers with distinct physical and chemical properties. When moving from the center of the planet toward the surface, the sequence begins with the solid inner core, followed by the liquid outer core. Next is the thick layer of the mantle, which makes up most of the Earth's volume. Finally, the outermost layer is the thin, solid crust. Understanding this internal arrangement is fundamental for studying the planet's overall structure and its internal geological dynamics throughout Earth's history.

120. (A) A solid aggregate of one or more minerals or mineraloids.
A rock is defined as a solid, naturally occurring aggregate composed of one or more minerals or mineraloids. While a mineral has a specific chemical formula and crystal structure, a rock is a more complex mixture that forms the bulk of the Earth's crust. Rocks are classified into three main types—igneous, sedimentary, and metamorphic—based on their mode of formation. This definition distinguishes rocks from individual minerals and from unconsolidated materials like soil or liquid substances like molten magma.

121. (B) 1, 2 and 3
The formation and evolution of landforms are controlled by the interaction of internal and external forces. Tectonic forces, explained by the theory of plate tectonics, are responsible for creating primary features like mountain ranges and ocean basins through crustal movements. External climatic forces, such as weathering and erosion, then sculpt and modify these features over time. It is important to note that human activities can also significantly impact landforms through mining and construction, altering the natural processes of landscape development.

122. (B) Coriolis force
The Coriolis force is an apparent force caused by the Earth's rotation on its axis. As the planet rotates, it causes moving objects, such as air currents and ocean water, to be deflected from a straight path. In the Northern Hemisphere, this deflection is always to the right of the direction of motion, while in the Southern Hemisphere, it is to the left. This force is a fundamental component of atmospheric circulation, influencing the direction of global winds and storms.

123. (C) Moist, warm winds blowing from the sea towards the land.

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94. (D) A rapid flow of snow down a slope.
An avalanche is a rapid and potentially destructive flow of snow down a mountain slope. This natural hazard typically occurs when a layer of snow loses its grip on the underlying surface and slides away, often triggered by factors like new snowfall, temperature changes, or physical disturbances. Avalanches are distinct from lava flows or wind-driven tornadoes; they are specifically associated with mass wasting in cold, mountainous environments where snowpack stability is compromised by gravity and environmental conditions.

95. (C) 1, 2 and 3
Effective hazard mitigation involves a combination of warning systems, resilient infrastructure, and strategic planning. Early warning systems are vital for tsunamis, while strict building codes help structures survive earthquakes. Flood management includes structural solutions like levees and non-structural measures such as zoning laws. However, it is important to understand that the goal of mitigation and prediction is not to prevent natural events from occurring, but rather to minimize their impact on lives and property through preparation and risk reduction.

96. (A) The balance between incoming solar radiation and outgoing terrestrial radiation.
The Earth's energy budget describes the balance between the amount of solar radiation received from the sun and the amount of terrestrial radiation the Earth emits back into space. This balance is fundamental to maintaining a stable global temperature. If the incoming energy exceeds the outgoing energy, the planet warms; if the opposite occurs, it cools. This equilibrium is influenced by factors like atmospheric composition and surface reflectivity, playing a central role in driving the Earth's climate system.

97. (B) Rate of cooling of magma or lava.
Igneous rocks are formed from the solidification of molten material. The primary control on the resulting rock's texture and characteristics is the rate at which the magma or lava cools. Rapid cooling on the Earth's surface leads to the formation of fine-grained volcanic rocks with small crystals. Conversely, slow cooling deep within the crust allows for the growth of large, visible crystals, resulting in coarse-grained intrusive rocks like granite. This cooling rate is the defining factor in petrogenesis.

98. (C) Pressure gradient force and Coriolis force
A geostrophic wind is a theoretical atmospheric model that describes wind flowing at a constant speed and direction. This state occurs when the horizontal pressure gradient force, which pushes air toward lower pressure, is exactly balanced by the Coriolis force, which deflects the air due to the Earth's rotation. In this frictionless environment, usually found high in the troposphere, the resulting wind blows parallel to the isobars rather than crossing them, providing a basis for understanding global weather patterns.

99. (D) It is the cool phase of the El Niño-Southern Oscillation (ENSO) cycle.
La Nina is a significant climate event that represents the cool phase of the El Nino-Southern Oscillation cycle. It is characterized by unusually cold sea surface temperatures in the central and eastern tropical Pacific Ocean. During La Nina, the trade winds strengthen, pushing warmer water further west and causing intensified upwelling of cold water in the east. This shift has global impacts on weather, often leading to increased rainfall in some regions and drier conditions in others.

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100. (B) P-2, Q-1, R-4, S-3
The Earth is divided into layers with different physical states. The inner core is solid due to extreme pressure, while the outer core is liquid. The mantle includes the asthenosphere, which behaves in a plastic or partially molten manner, allowing for convection. The outermost layer is the crust, which is solid and brittle. This combination of liquid and solid zones is essential for processes like the generation of the magnetic field and the movement of tectonic plates across the surface.

101. (C) Remains in the reservoir for a long period.
Residence time is a measure of how long a substance stays within a specific reservoir, such as a lake or the atmosphere. A very long residence time indicates that the substance is removed slowly, meaning it stays in the reservoir for an extended period. This can occur if the substance is chemically stable or if the processes

essential for maintaining the availability of nutrients required for life. The partitioning of these elements into different reservoirs depends on their specific chemical and physical properties. It is important to recognize that different elements recycle at different rates and that changes in paleoclimate can significantly influence these cycles over time. Therefore, the first three statements accurately describe these fundamental global processes.

131. (D) Atmosphere
The Earth is composed of several overlapping spheres, each with a unique elemental composition. The atmosphere is the gaseous envelope surrounding the planet and contains the highest concentrations of elements that exist primarily in a gas phase at surface temperatures. Nitrogen makes up about 78% of the atmosphere, while noble gases like argon are also significant components. While these elements can be found in small amounts in other spheres, they are overwhelmingly concentrated in the atmosphere as part of the air.

132. (B) The flow of energy from the sun and the Earth's interior.
The geochemical recycling of elements is driven by the continuous flow of energy from two primary sources: solar radiation and the Earth's internal heat. Solar energy drives surface processes like the hydrological cycle, weathering, and biological activity. Meanwhile, internal heat from radioactive decay and the planet's formation powers plate tectonics, volcanism, and metamorphism. Together, these energy sources move matter through different reservoirs, ensuring that elements are constantly redistributed and recycled across the Earth's various spheres over long geological timescales.

133. (C) Be doubled.
Darcy's Law defines a linear relationship between the groundwater flow rate and several key parameters, including the hydraulic gradient. This gradient represents the change in water pressure over a given distance. According to the formula, if all other factors like hydraulic conductivity and area remain constant, the flow rate is directly proportional to the gradient. Therefore, if the hydraulic gradient is doubled, the rate at which water moves through the porous medium will also be doubled, assuming flow remains laminar.

134. (D) Aquifuge
In hydro geology, different geological formations are classified based on their ability to store and transmit water. An aquifuge is a specific type of formation that is both impermeable and non-porous. It does not contain water and cannot transmit it, such as a solid, unfractured mass of crystalline rock like granite. This is distinct from an aquifer, which easily transmits water, or an aquitard, which restricts flow. Understanding these classifications is essential for mapping groundwater systems and managing regional water resources.

135. (A) Pore water removal leading to sediment compaction.
Land subsidence in areas with high groundwater extraction is primarily caused by the compaction of subsurface sediments. When large volumes of water are removed from the pore spaces between sediment grains, the fluid pressure that helps support the weight of overlying layers decreases. This leads to an increase in effective stress on the sediment framework, causing it to collapse and settle. As these layers compact, the ground surface sinks, potentially leading to permanent loss of aquifer storage capacity.

136. (B) Natural gas
Non-renewable resources are those that exist in a finite amount and cannot be replenished on a human timescale once they are consumed. Natural gas, a fossil fuel formed from ancient organic matter over millions of years, is a prime example of such a resource. In contrast, solar, wind, and geothermal energy are considered renewable because they are naturally replenished and will not be depleted by human use. Judicious management of non-renewable resources like natural gas is necessary for long-term energy security.

137. (C) Ensuring the sustainable use of resources for present and future generations.
Conservation of natural resources is the practice of managing Earth's materials in a way that ensures their availability for both current and future generations. The core objective is sustainable use, which involves balancing

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The abundance of elements in the hydrosphere is not the same as in the crust; instead, it is determined by the solubility of minerals and the residence time of elements in water. Elements that are highly soluble or have long residence times will be more concentrated in seawater. For instance, while silicon is extremely abundant in the crust, it is relatively sparse in the ocean compared to elements like sodium and chlorine, which are more easily dissolved into solution.

80. (A) Hydro geology
Hydro geology is the specific branch of geology that focuses on the distribution, movement, and quality of water located beneath the Earth's surface. It examines how groundwater interacts with various soil and rock formations, including its flow through aquifers and its chemical evolution. While hydrology is a broader term covering all aspects of water on Earth, hydro geology specifically addresses the complex relationships between water and the solid materials of the crust, ensuring sustainable management and protection of groundwater.

81. (A) 1 and 3 only
India's groundwater landscape is diverse and faces significant challenges. The Indo-Ganga-Brahmaputra plains contain some of the world's most productive alluvial aquifers. However, in many agricultural regions, over-extraction is a major concern, leading to falling water levels. Furthermore, the Deccan Trap basalts are generally hard and low in porosity, making them less productive as aquifers. It is also important to note that groundwater quality varies significantly across the country and is not uniformly excellent due to regional contaminants.

82. (B) 40 times the head
The Ghyben-Herzberg relation is used to estimate the position of the boundary between fresh and saline groundwater in coastal regions. Based on the density difference between fresh and seawater, the principle states that for every meter the freshwater table rises above sea level, the freshwater-saltwater interface will be approximately forty meters below sea level. This 1-to-40 ratio is critical for water resource managers to understand the risk of saltwater intrusion when pumping groundwater near vulnerable coastlines.

83. (A) Both A and R are true and R is the correct explanation of A.
Unsustainable groundwater use has severe environmental consequences, as highlighted by both the assertion and the reason. When water is pumped from an aquifer faster than it can naturally recharge, the water table drops, causing wells to dry up. Furthermore, the removal of water reduces pore pressure, which can lead to the compaction of fine-grained sediments. This subsurface settling manifests at the surface as land subsidence, potentially damaging infrastructure and increasing flood risks in affected urban areas.

84. (C) Laminar flow conditions
Darcy's Law provides a linear relationship between the flow rate and the hydraulic gradient in a porous medium. However, this mathematical model is only valid under laminar flow conditions, where the fluid moves in smooth, parallel layers with low velocity. When flow becomes turbulent—typically at high velocities or in very large pores—the relationship becomes non-linear, and Darcy's Law no longer accurately predicts the behavior of the groundwater. Most natural groundwater flow, however, remains within the laminar regime.

85. (B) Natural geological formations rich in arsenic-bearing minerals.
While human activities can contribute to pollution, the most common source of widespread arsenic contamination in groundwater is natural geological formations. Certain sedimentary deposits and rocks contain minerals rich in arsenic. Under specific chemical conditions, such as reducing environments found in deep aquifers, this arsenic can dissolve into the groundwater. This natural process has led to significant public health issues in regions like the Bengal Basin, where groundwater is a primary source of drinking and irrigation water supplies.

86. (D) Hydraulic conductivity
Hydraulic conductivity, often denoted by the symbol K, is a property that describes the ease with which a fluid can move through the pore spaces or fractures of a solid material. It is a central parameter in Darcy's Law and depends on both the permeability of the medium, such as soil or rock, and the viscosity of the fluid. High hydraulic conductivity indicates that water can

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it has the greatest influence on atmospheric circulation.

145. (D) A is false but R is true.
The Earth's energy budget is not a closed system because it relies on external energy inputs, primarily in the form of electromagnetic radiation from the Sun. This solar radiation is the fundamental source of energy that powers the Earth's climate, weather, and biological processes. While the planet emits terrestrial radiation back into space, the continuous influx of solar energy is what maintains the Earth's temperature and drives its various environmental cycles. Therefore, the assertion is false, but the reason identifies the primary energy source.

146. (B) Alteration of pre-existing rocks by heat and pressure without melting
Metamorphic rocks are created through the alteration of pre-existing igneous, sedimentary, or other metamorphic rocks. This transformation occurs deep within the Earth's crust, where rocks are subjected to intense heat and high pressure. These conditions cause the minerals within the rock to recrystallize or react with one another to form new mineral assemblages and textures. Crucially, this process happens while the rock remains in a solid state; complete melting would instead lead to the formation of magma.

147. (D) Igneous Rock - Formed from solidification of magma
Rock types are classified based on their unique formation processes. Igneous rocks specifically form from the cooling and solidification of molten material, known as magma when beneath the surface or lava when above. Sedimentary rocks form from the accumulation and cementation of mineral and organic fragments, while metamorphic rocks result from the alteration of existing rocks by heat and pressure. Correctly identifying that igneous rocks originate from solidified magma is a fundamental concept in understanding the Earth's crust and the rock cycle.

148. (A) Both Statement I and Statement II are true.
Physical and chemical weathering are complementary processes that work together to break down rocks. Physical weathering disintegrates rock into smaller pieces, which significantly increases the total surface area available for chemical reactions to occur. Conversely, chemical weathering can alter and soften mineral structures, making the rock more vulnerable to mechanical breakdown by forces like wind or ice. Both statements are true, highlighting the synergistic relationship between these two types of weathering in reshaping the Earth's surface and contributing to soil development.

149. (C) Erosion
Erosion is the natural process in which soil and rock fragments are loosened and transported from their original location by various environmental agents. Water in the form of rain or flowing streams is a primary driver, as is the force of wind and moving glaciers. Unlike weathering, which breaks material down in place, erosion focuses on the physical movement and removal of these particles. This continuous process reshapes landscapes, carves river valleys, and moves vital nutrients across the surface over time.

150. (A) Parent Material
In soil science, the factors influencing soil formation are often classified as active or passive. Active factors, such as climate and biological organisms, provide the energy and materials that drive the transformation of the soil. Passive factors, on the other hand, provide the initial framework or the stage upon which these processes act. Parent material is considered a passive factor because it represents the original geological substance that is being weathered and transformed into soil, rather than being a driver itself.

151. (D) pH
Soil properties are divided into physical and chemical categories to better understand their behavior. Physical properties include texture, structure, and porosity, which describe the size and arrangement of particles. Chemical properties, however, involve the molecular and ionic characteristics of the soil. The pH level is a key chemical property that measures the acidity or alkalinity of the soil solution. This influences nutrient availability and the activity of soil organisms, making it essential for evaluating soil health and its suitability.

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Earth's crust, where rocks are subjected to high temperatures and intense pressure, often in the presence of chemically active fluids. These agents cause minerals to recrystallize and reorganize into new textures and compositions while the rock remains in a solid state. This process is distinct from weathering or erosion, which occur at the surface, and sedimentation, which involves accumulation of fragments.

211. (B) Rocks and minerals seeking equilibrium with surface conditions.
The fundamental cause of weathering is the interaction between rocks and the Earth's surface environment. Most rocks and minerals form under high pressure and temperature deep within the crust. When these materials are exposed at the surface, they are no longer in equilibrium with the lower temperatures, lower pressures, and presence of water and oxygen. Weathering is the process by which these minerals chemically and physically adjust to reach a more stable equilibrium with surface conditions, leading to rock disintegration.

212. (D) Negative charge capacity for holding nutrient cations.
Cation Exchange Capacity is a critical soil property that measures the total negative charge capacity of the soil particles. This charge allows the soil to hold and exchange positively charged ions, or cations, such as calcium, magnesium, and potassium. These ions are essential nutrients for plants. The capacity is primarily provided by the microscopic surfaces of clay minerals and organic matter. A high value indicates a greater ability to store these nutrients, preventing them from being leached away during rainfall.

213. (D) Statement I is false but Statement II is true.
Geochemical recycling is a broad concept that describes the continuous movement of elements through all of Earth's various spheres, not just the crust. It involves complex interactions between the atmosphere, hydrosphere, lithosphere, and biosphere. The carbon cycle is a quintessential example, illustrating how carbon moves between the air, water, and living organisms. Therefore, while the first statement is incorrect because it overly restricts the scope of recycling, the second statement accurately identifies a prime example of this global process.

214. (C) Coastal areas
The Ghyben-Herzberg relation is a fundamental principle used by hydrogeologists specifically to manage groundwater resources in coastal environments. It describes the physical relationship and equilibrium between freshwater and saline groundwater. Because of the density difference between the two, freshwater floats as a lens on top of the heavier seawater. Understanding this balance is critical for preventing saltwater intrusion into coastal wells, as it allows water managers to determine the sustainable rate of pumping that avoids contaminating the supply.

215. (C) 1, 2 and 3
The exploration and exploitation of natural resources are complex activities with significant environmental and social implications. Extraction often leads to pollution and habitat loss, highlighting the need for conservation due to the finite nature of non-renewable resources. Historically, there has been a growing awareness of the importance of sustainable management. However, it is incorrect to assume that resource exploitation has no negative social impacts, as it can displace communities. Therefore, the first three statements reflect these evolving perspectives.

216. (B) Landslide
A landslide is a type of geological hazard that is primarily driven by the force of gravity acting on a steep or unstable slope. When the gravitational pull exceeds the internal strength of the rock and soil, the material moves downslope as a mass. Factors such as heavy rainfall, earthquakes, or human activities can trigger this movement by reducing friction or increasing weight. Unlike earthquakes or volcanic eruptions, which originate from internal tectonic forces, a landslide is a surface-level mass wasting process.

217. (C) The collision of tectonic plates.
The formation of massive mountain ranges like the Himalayas is primarily the result of large-scale tectonic processes. In this specific case, the collision of the Indian Plate with the Eurasian Plate caused the crust to thicken and buckle, pushing the land upwards over millions of years. This ongoing process of continental collision is far more significant than the roles played by volcanic eruptions or erosion in creating such

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destructive; it also creates new land and fertile soil. Furthermore, tsunamis are not tidal waves caused by the moon's gravity; they are generated by sudden water displacements from events like submarine earthquakes. Only statements 1 and 3 are accurate.

160. (B) Constructing buildings according to seismic design codes.
The most effective long-term strategy for reducing the risk posed by earthquakes is the implementation of seismic design codes in building construction. These engineering standards ensure that structures are designed to withstand the shaking and lateral forces generated during an earthquake, preventing collapse and saving lives. While early warning sirens can provide notice, they do not protect the buildings themselves. Proper construction techniques remain the primary mitigation tool for creating resilient communities in seismically active regions around the world.

161. (C) Theory that Earth's outer shell is divided into moving plates.
Plate tectonics is a fundamental scientific theory that describes the Earth's outer shell, the lithosphere, as being divided into several large and small rigid plates. These plates are in constant, slow motion, driven by convection currents within the underlying mantle. This movement explains many of the Earth's major geological features and processes, including the formation of mountains, the occurrence of earthquakes, and the distribution of volcanoes and ocean basins. It provides a unified framework for understanding geological history.

162. (D) The Earth's axial tilt and its revolution around the Sun.
The Earth's seasons are caused by the interaction of its 23.5-degree axial tilt and its annual revolution around the Sun. As the planet orbits, the tilt ensures that different parts of the Earth receive varying amounts of direct sunlight at different times of the year. This variation in solar intensity and day length creates the distinct seasonal cycles of spring, summer, autumn, and winter. The shape of the orbit and solar output fluctuations play only a minor role.

163. (A) Both Statement I and Statement II are true.
The gradient wind concept is an extension of the geostrophic wind model that applies to air flowing along curved paths. In a geostrophic wind, only the pressure gradient and Coriolis forces are balanced. However, when air moves along curved isobars, a centrifugal force is also present, acting outward from the center of curvature. A gradient wind represents the theoretical balance between all three of these forces—pressure gradient, Coriolis, and centrifugal. Both statements correctly describe the nature of this flow.

164. (D) A prolonged precipitation deficiency causing water shortage.
A drought is characterized as a prolonged period during which a region receives significantly less precipitation than normal, leading to a serious water shortage. Unlike sudden events like floods, a drought develops gradually and can last for months or years. This deficiency impacts soil moisture, groundwater levels, and surface water supplies, affecting agriculture, ecosystems, and human communities. It is a slow-onset hazard that requires long-term management of water resources and careful planning to mitigate broad social impacts.

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165. (B) 1, 2, 3 and 4
The Earth's surface is constantly reshaped through a sequence of interconnected processes. Weathering breaks down rocks in place, providing the material that erosion then removes and transports across the landscape. Transportation involves the movement of these sediments by agents like water or wind, and deposition is the final settling of the material in a new location. These processes are highly dependent on one another, as each stage relies on the preceding one, making the first four statements correct.

166. (B) Hydrolysis
Physical weathering involves the mechanical breakdown of rock into smaller fragments without changing its chemical composition. Common types include frost wedging, abrasion by wind or water, and thermal expansion. In contrast, hydrolysis is a chemical weathering process where water reacts with minerals to create new substances, such as clay minerals. Because hydrolysis involves a change in the chemical identity of the mineral constituents, it is classified as chemical rather than physical

climate phenomena and their typical impacts on regional weather patterns.

196. (D) The in-place disintegration of surface rock.
Weathering is a fundamental geological process characterized by the in-place disintegration and decomposition of rocks at or near the Earth's surface. This breakdown can occur through physical means, like freezing and thawing, or chemical means, such as dissolution and oxidation. Unlike erosion, which involves the transport of material, weathering is a localized process that transforms solid rock into loose fragments and minerals. It is a critical first step in soil formation and the overall shaping of landscapes.

197. (A) The dissolution of minerals by acidic water.
Chemical weathering involves the alteration of mineral structures through chemical reactions with environmental agents. A key process in this category is dissolution, where minerals are dissolved by water, often made slightly acidic by dissolved carbon dioxide. This process is particularly effective on carbonate rocks like limestone. Unlike mechanical processes like abrasion or frost-thaw action, dissolution changes the chemical identity of the minerals involved. This chemical breakdown is essential for soil formation and for the release of nutrient ions.

198. (A) Both A and R are true and R is the correct explanation of A.
The natural resource potential of any given region is deeply rooted in its geological history. Over billions of years, various Earth processes such as magmatism, sedimentation, and metamorphism have acted to move and concentrate elements into localized deposits. For instance, volcanic activity can bring precious metals to the surface, while ancient sedimentary basins can store fossil fuels. Therefore, both the assertion and the reason are true, as understanding these historical geological events is fundamental to locating economically viable resources today.

199. (C) Global Hydrology
Global Hydrology is the scientific study that examines the distribution, movement, and storage of water across the Earth's various reservoirs, including ice caps, groundwater, and surface water bodies like lakes and rivers. It focuses on understanding the entire water cycle and how water moves between these reservoirs over different scales of time and space. This field is essential for managing water resources, predicting climate impacts on availability, and recognizing how the hydrosphere interacts with other Earth spheres.

200. (B) P-4, Q-3, R-1, S-2
Mitigation measures are specific strategies designed to reduce the impact of various natural hazards. Earthquake risk is mitigated through strict seismic building codes. Flood damage can be reduced by constructing levees and floodwalls to contain excess water. Landslides are addressed through slope stabilization and drainage control to prevent water saturation. Volcanic risk is managed by monitoring seismicity and gas emissions to provide early warnings. Correctly matching these hazards with their corresponding mitigation techniques is vital for creating safer communities.

201. (D) The relative proportions of sand, silt, and clay.
A soil's physical properties, such as its ability to hold water, its porosity, and how easily air moves through it, are primarily controlled by its texture. Soil texture is defined by the relative proportions of sand, silt, and clay particles. Sand provides large pores for drainage, while clay has tiny pores that retain moisture. By balancing these different sized particles, the soil's physical behavior is established. Other factors like magnetism have no measurable impact on physical soil characteristics.

202. (B) Their affinity for silicate, metal, or gas phases.
The geochemical classification of elements, as established by Goldschmidt, is based on the chemical affinity of elements for different coexisting phases during early differentiation. Elements are grouped according to whether they prefer to associate with silicate minerals (lithophile), metallic phases like iron (siderophile), sulfide ores (chalcophile), or gas phases (atmophile). This affinity determines where elements are primarily located within Earth's layers and reservoirs, providing a fundamental framework for understanding the chemical structure and overall composition of our planet.

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Non-renewable resources are those that exist in a finite quantity and cannot be naturally replaced at a rate fast enough to keep up with human consumption. Petroleum is a quintessential non-renewable resource, as it forms from ancient organic matter over millions of years under specific geological conditions. Once extracted and burned, it cannot be replenished on a human time scale. In contrast, timber, hydropower, and fish are potentially renewable if managed sustainably, making petroleum the correct example of a finite resource.

175. (A) P-3, Q-4, R-1, S-2
Natural hazards are classified based on their primary causes and physical characteristics. An earthquake is triggered by a sudden slip along a fault, while a landslide involves the downs lope movement of rock and soil under gravity. Floods are defined as the overflow of water onto normally dry land, and volcanoes involve the eruption of molten rock and ash. Correctly matching these hazards with their fundamental descriptions is essential for understanding the diverse geological and hydrological processes that can impact human societies.

176. (B) Monitoring rainfall and river discharge levels.
The prediction and monitoring of floods rely heavily on tracking meteorological and hydrological data. A critical component of this process is the continuous monitoring of rainfall amounts and river discharge levels. By analyzing how much water is falling and how fast the river's volume is increasing, scientists can use computer models to forecast when and where a river might exceed its banks. This real-time data is vital for issuing timely warnings to at-risk communities to prepare for inundation.

177. (C) Extremely heavy precipitation in a short period over a limited area.
A cloud burst is an extreme meteorological phenomenon characterized by exceptionally heavy and concentrated precipitation occurring over a very short period within a small geographic area. These events often deliver more than 100 millimeters of rain in a single hour, leading to sudden and violent flash floods. This concentrated deluge is far more intense than typical monsoon rains and can cause immediate, severe damage to infrastructure, particularly in mountainous regions where the terrain funnels the rapid runoff.

178. (D) Interior outgassing during intense volcanic activity.
The Earth's atmosphere and hydrosphere were primarily formed through the process of interior outgassing. During the planet's early history, intense volcanic activity released various volatile compounds, such as water vapor, carbon dioxide, and nitrogen, from the Earth's interior. As the planet cooled, the water vapor condensed to form the oceans, while the other gases accumulated to create the initial atmosphere. This internal origin provided the essential components for the development of life and the various environmental cycles that exist today.

179. (A) Sedimentary
Sedimentary rocks are formed from the accumulation and lithification of various types of sediment. This specifically includes rocks composed of cemented fragments of pre-existing rocks, known as clastic sedimentary rocks. After rocks are broken down by weathering and transported by agents like water or wind, the resulting fragments settle and are eventually buried. Over time, the pressure from overlying layers and the precipitation of mineral cements bind these fragments together into a solid rock mass, completing the sedimentary cycle.

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180. (B) The Earth would warm up.
The Earth's energy budget is a delicate balance between incoming solar radiation and outgoing terrestrial radiation. If there were a sustained increase in the amount of solar energy reaching the Earth without an equivalent increase in the energy radiated back into space, the planet would begin to accumulate heat. This net energy gain would cause the Earth's overall temperature to rise, leading to global warming. Such a shift would significantly alter climate patterns, melt ice caps, and impact ecosystem stability.

181. (C) Coriolis Force
The counter-clockwise rotation of cyclones in the Northern Hemisphere is a direct result of the Coriolis force. As air is drawn toward the low-pressure center of a cyclone by the pressure gradient force, the Earth's rotation causes the moving air to be deflected to the right. This

weathering, distinguishing it from mechanical processes.

167. (D) Soil Structure
Soil structure refers to the way individual soil particles—sand, silt, and clay—cluster and bind together to form larger clumps known as aggregates or peds. This property is distinct from soil texture, which only describes the proportions of different particle sizes. A well-developed soil structure is vital for healthy ecosystems because it creates a network of pores that allow for the movement of air and water and provide space for root growth. This arrangement is influenced by organic matter.

168. (D) A is false but R is true.
While the parent material provides the initial mineral foundation for soil, it is not the only factor that determines the final soil type. The process of soil formation is heavily influenced by other factors, especially climate and biological activity, which actively modify the parent material over long periods. These forces can cause chemical transformations and translocations that lead to a soil profile very different from the original rock. Therefore, while the assertion is false, the reason correctly describes soil-forming factors.

169. (C) The amount and type of clay and organic matter.
The Cation Exchange Capacity is a soil's ability to hold and supply vital nutrients, and it is primarily controlled by the amount and type of clay minerals and organic matter present. These components have microscopic surfaces with net negative electrical charges that attract and hold positively charged ions, such as calcium and potassium. Soils with high clay or organic content generally have a higher capacity to store these nutrients, preventing them from leaching away and ensuring availability for uptake by plants.

170. (A) Movement of elements through Earth's various spheres.
Geochemical recycling is the continuous movement of chemical elements through the Earth's various overlapping spheres, including the atmosphere, hydrosphere, lithosphere, and biosphere. This process involves the transformation of elements between different chemical forms and their redistribution across various reservoirs over a wide range of timescales. Cycles like those of carbon, nitrogen, and phosphorus are prime examples. Understanding these cycles is essential for recognizing how the Earth maintains the balance of materials necessary for geological and biological stability.

171. (D) The requirements of living organisms.
The abundance and distribution of elements within the biosphere are primarily determined by the specific requirements and processes of living organisms. Elements such as carbon, hydrogen, nitrogen, and oxygen are highly concentrated in the biosphere because they are the fundamental building blocks of organic molecules. Organisms actively take up and cycle these and other essential nutrients from their environment to support growth, reproduction, and metabolism. Therefore, biological necessity drives the chemical composition of this sphere, distinguishing it from others.

172. (B) A lowering of the water table.
The excessive extraction of groundwater from an unconfined aquifer leads to a direct and measurable lowering of the water table. This occurs when the rate of pumping exceeds the rate at which water can naturally recharge the aquifer from precipitation or other sources. As the water level drops, wells may go dry and the connection between the groundwater and surface water bodies like streams or wetlands can be disrupted. This decline represents a significant challenge for sustainable resource management in many regions.

173. (C) Over-pumping of fresh groundwater causing saline intrusion.
For coastal communities, the primary concern related to the Ghyben-Herzberg relation is the risk of saltwater intrusion. This principle describes the balance between fresh and saline groundwater. Because freshwater is less dense, it forms a lens floating above the heavier saltwater. When fresh groundwater is over-pumped, the resulting drop in the water table allows the denser saline water to move inland and upward into the aquifer. This contamination can make local wells unusable for drinking, posing a threat to water security.

174. (D) Petroleum

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identifying recharge zones, and predicting how quickly contaminants might spread through an aquifer. Tracers provide a direct way to observe subsurface behavior.

189. (A) The generation of large amounts of waste rock and tailings, which can pollute water.
Large-scale mining operations pose significant environmental challenges, particularly regarding the management of waste materials. The process of extracting minerals generates vast quantities of waste rock and tailings, which are the finely ground materials left after processing. These waste products often contain harmful chemicals or heavy metals that can leach into local groundwater and surface water bodies, causing extensive pollution. This contamination can devastate aquatic ecosystems and impact human health, representing a major concern for the responsible exploitation of mineral resources.

190. (B) Constructing buildings according to seismic design codes.
Effective earthquake mitigation focuses on proactive measures taken before a disaster occurs to reduce the potential for damage and loss of life. A primary strategy is the enforcement of strict seismic design codes for all new buildings and infrastructure. These codes ensure that structures are engineered to remain stable and resist the intense shaking and lateral forces generated during an earthquake. By making the built environment more resilient, society can significantly lower the overall risk and impact of future seismic events.

191. (C) The crust and the mantle.
The Mohorovičić discontinuity, commonly referred to as the Moho, is a fundamental internal boundary within the Earth. It marks the transition between the outermost layer, the crust, and the underlying mantle. This boundary was discovered by observing changes in the velocity of seismic waves as they travel through different materials. Because the mantle is composed of denser rocks compared to the crust, seismic waves accelerate as they pass through the Moho, providing a way to map the thickness of Earth's layers.

192. (D) Coriolis force
The Coriolis force is a unique physical phenomenon that arises directly from the Earth's rotation on its axis. As the planet turns, it causes moving objects, such as winds and ocean currents, to follow a curved path relative to the surface. This deflection occurs to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. Unlike the pressure gradient force or gravity, the Coriolis force only affects objects already in motion and is essential for global atmospheric circulation.

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193. (C) Magma is subsurface molten rock; lava is surface.
The terms magma and lava both refer to molten rock, but they are distinguished by their location relative to the Earth's surface. Magma is the molten material that exists beneath the surface, within the crust or mantle. When this material erupts through a volcano or fissure and reaches the Earth's exterior, it is then referred to as lava. This distinction is important because the different cooling environments—underground versus on the surface—result in igneous rocks with distinct textures and crystal sizes.

194. (B) The Earth's Van Allen belts
Landform development is a complex process shaped by several key factors. Tectonic activity creates primary structures through crustal movements, while climate and rock type determine how these features are weathered and eroded over time. These are direct, physical controls on surface morphology. In contrast, the Van Allen belts are zones of energetic charged particles trapped by the Earth's magnetic field high in the magnetosphere. They are important for space weather but exert no physical influence on landform sculpting.

195. (A) 1 and 2 only
The Indian climate is shaped by several large-scale atmospheric patterns. The monsoon is a seasonal wind reversal driven by the differential heating of land and sea. In winter, western disturbances originating in the Mediterranean bring rain to northern regions. However, El Nino events are generally associated with weaker monsoons, while La Nina involves the cooling of the central and eastern tropical Pacific. Therefore, only the first two statements correctly describe these

152. (A) P-4, Q-1, R-3, S-2
The Goldschmidt classification system groups elements based on where they tend to concentrate within the Earth's layers. Siderophile elements have an affinity for metal and are primarily found in the iron-rich core. Lithophile elements prefer silicate minerals and are concentrated in the crust and mantle. Atmophile elements exist mainly as gases in the atmosphere, while chalcophile elements associate with sulfur and are typically found in sulfide ores. This matching reflects the fundamental chemical partitioning that occurred during Earth's differentiation.

153. (C) Fractional crystallization.
Fractional crystallization is a geological process that occurs during the cooling of magma. As temperatures drop, different minerals crystallize and settle out of the melt at different times based on their melting points. This results in the partitioning of elements, as those that fit into the early-forming crystals are removed from the remaining liquid magma. This process leads to the formation of a variety of igneous rocks with different chemical compositions from a single original magma source, illustrating element segregation.

154. (D) Approximately 3%
The Earth is often called the water planet, but the vast majority of its water is saline and found in the oceans. Freshwater accounts for only a very small fraction, approximately 3% of the total water on the planet. Of this small amount, a significant portion is locked away in glaciers and polar ice caps, or stored deep underground. Accessible surface freshwater in lakes and rivers represents an even tinier percentage, highlighting the importance of protecting these limited water resources.

155. (A) Darcy's Law
Darcy's Law is the foundational principle used in hydrogeology to describe how groundwater moves through porous materials like soil, sand, and rock. It provides a mathematical relationship showing that the flow rate is proportional to the hydraulic conductivity of the medium and the hydraulic gradient. While other concepts like the Ghyben-Herzberg relation deal with specific coastal conditions, Darcy's Law offers the universal framework for calculating the velocity and volume of water moving through the Earth's various subsurface aquifers.

156. (B) Groundwater fluctuations.
Groundwater levels are not static but change in response to various environmental factors. Seasonal variations in precipitation and the subsequent recharge of aquifers lead to groundwater fluctuations, where the water table rises and falls over time. During wet seasons, increased infiltration causes the water table to rise, while in dry periods or during heavy extraction, it may drop significantly. Monitoring these fluctuations is essential for managing water supplies, understanding the health of an aquifer, and predicting the availability of water.

157. (C) Increased streamflow in connected rivers
Excessive withdrawal of groundwater can lead to several negative environmental impacts, including land subsidence, a significant lowering of the water table, and the intrusion of saltwater into coastal aquifers. These processes occur when water is removed faster than it can be naturally replenished. However, over-pumping does not increase the flow of water into nearby rivers. Instead, it often disconnects the aquifer from the surface, leading to reduced streamflow or the drying up of springs and connected wetlands.

158. (D) They are finite and extraction has severe consequences.
The conservation of non-renewable resources is based on the critical understanding that these materials, such as fossil fuels and minerals, exist in limited quantities. These resources take millions of years to form, meaning they cannot be replaced on a human timescale once they are depleted. Furthermore, the processes of extraction and use often have severe environmental and social consequences. Conservation efforts aim to extend the lifespan of these resources through sustainable management, efficiency, and recycling for future use.

159. (A) 1 and 3 only
Natural hazards arise from various geological and atmospheric processes. Earthquakes are caused by the sudden release of tectonic energy, and floods can result from diverse triggers like heavy rain or dam failures, making these statements correct. However, volcanism is not exclusively

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203. (A) Both Statement I and Statement II are true.
Land subsidence is a geological phenomenon where the Earth's surface sinks or settles. While it can occur through natural processes, human activities are often a significant driver. A major anthropogenic cause is the excessive withdrawal of groundwater from aquifers. As water is removed, the fluid pressure that helps support the surrounding soil and rock decreases, leading to compaction of the subsurface layers. Both statements are accurate, highlighting how unsustainable water use can lead to permanent and often destructive surface changes.

204. (D) Using the resource wisely and efficiently to extend its availability.
With respect to non-renewable resources, conservation is defined as the wise and efficient use of finite materials to ensure they remain available for as long as possible. This approach focuses on reducing waste, improving extraction technologies, and promoting recycling and the development of sustainable alternatives. Conservation does not mean stopping all use or ignoring environmental impacts. Instead, it involves responsible management that balances modern needs with the reality of resource scarcity, aiming for long-term availability for future generations.

205. (A) 1 and 3
Natural hazards are diverse and complex geological and atmospheric events. A landslide is indeed a form of mass wasting, and volcanism has both destructive impacts and constructive effects, such as forming new land and fertile soil. However, tsunamis are highest near the coast, not in the deep ocean, and earthquake prediction is not yet a precise science. Avalanches specifically involve the rapid flow of snow down slopes. Therefore, only the first and third statements are accurate descriptions of these phenomena.

206. (A) A hazard is a natural event, while a disaster is the consequence of that event on a vulnerable population.
In disaster management, a critical distinction is made between a hazard and a disaster. A hazard is a natural or human-made event, such as an earthquake or a hurricane, that has the potential to cause harm. A disaster, however, is the actual consequence of that event when it impacts a vulnerable human population, resulting in significant loss of life, property damage, or social disruption. Without the exposure of people and infrastructure, a natural hazard remains a geological or meteorological process.

207. (B) Gradual soil creep
Catastrophic geological hazards are those that occur suddenly and have the potential to cause immediate and widespread destruction. Earthquakes, volcanic eruptions, and tsunamis fit this definition because they involve high-energy events with rapid onsets and devastating impacts. In contrast, gradual soil creep is a slow-motion form of mass wasting that occurs over years or decades. While it can cause minor damage to fences or roads over time, its extremely slow pace and non-violent nature exclude it from this category.

208. (C) Differentiation
Differentiation is the fundamental geochemical process that occurred during the Earth's early, molten stage, leading to the formation of its primary internal layers. Driven by gravity, dense materials like metallic iron and nickel sank to the center to form the core. Simultaneously, lighter silicate minerals rose toward the surface, eventually solidifying into the mantle and the crust. This density-based sorting transformed the Earth from a homogenous body into a stratified planet with distinct chemical and physical zones established today.

209. (D) The differential heating between the Asian landmass and the Indian Ocean
The primary driver of the Indian monsoon is the differential heating that occurs between the massive Asian landmass and the vast Indian Ocean. During the summer, the land heats up much more rapidly than the water, creating a strong low-pressure zone over the continent. This draws in moist air from the high-pressure area over the cooler sea. As this air moves onto the land and encounters rising terrain, it releases heavy precipitation. This seasonal atmospheric circulation is essential for regional agriculture.

210. (C) Metamorphism
Metamorphism is the geological process that involves the transformation of existing rocks into new forms. This occurs deep within the

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continuous rightward deflection around the low-pressure zone creates the characteristic spiral motion. In the Southern Hemisphere, the deflection is to the left, causing cyclones there to spin in a clockwise direction, illustrating the global influence.

182. (A) 2, 3, 4, 1
A soil profile consists of several distinct horizontal layers called horizons that develop over time. Starting from the surface and moving downwards, the sequence typically begins with the topsoil, also known as the A horizon, which is rich in organic matter. Below this is the subsoil, or B horizon, where minerals and nutrients accumulate. This is followed by the parent material, the C horizon, which consists of partially weathered rock. Finally, at the base, lies the solid bedrock, designated R.

183. (D) The process is very rapid, forming mature soils in a decade.
Soil formation, or pedogenesis, is a complex process involving the interaction of climate, organisms, topography, and parent material over time. It is driven by four basic mechanisms: additions, losses, translocations, and transformations. While climate and biological activity are indeed active factors, it is a common misconception that soil formation is rapid. In reality, it is an extremely slow geological process, often requiring hundreds to thousands of years to produce a mature and well-developed soil profile across any region.

184. (B) Control key properties like swelling and nutrient retention.
Characterizing clay minerals is a vital task in soil science because different types of clay possess vastly different physical and chemical properties. These minerals have a dominant influence on a soil's ability to retain nutrients through cation exchange and its capacity to hold water. Furthermore, some clays are expansive, meaning they swell significantly when wet and shrink when dry, which can impact soil stability and construction. Understanding specific mineral types is therefore essential for evaluating soil fertility and managing agriculture effectively.

185. (A) Both Statement I and Statement II are true.
The geochemical classification of elements provides a framework for understanding how different chemical components are distributed across the Earth. Elements that share similar geochemical behavior—such as their affinity for silicate, metallic, or sulfide phases—tend to behave in predictable ways during geological processes. This means they are often concentrated in similar geological environments, such as the crust, core, or specific ore deposits. Both statements are true, as this classification is a powerful tool for exploring and managing mineral resources.

186. (D) All of the above.
The concept of partitioning refers to the segregation and distribution of chemical elements between different coexisting phases during various geological and environmental processes. This phenomenon is fundamental to several key areas: it explains how magma evolves as minerals crystallize, how economic ore deposits form through the concentration of specific minerals, and how distinct soil horizons develop through the movement and accumulation of chemical components. Therefore, partitioning is a critical concept that applies to magma evolution, ore formation, and soil development.

187. (C) 80 meters
According to the Ghyben-Herzberg relation, there is a specific ratio between the height of the freshwater table above sea level and the depth of the freshwater-saltwater interface below it. This ratio is approximately 1 to 40, based on the density difference between fresh and saltwater. Therefore, if the water table is lowered by 2 meters, the underlying saline interface will experience a corresponding rise that is 40 times that amount. This results in the saltwater rising by 80 meters, illustrating over-pumping risks.

188. (D) The flow direction and velocity of groundwater.
Groundwater tracers are substances introduced into an aquifer to track the movement of water through the subsurface. By measuring how long it takes for the tracer to move from an injection point to various monitoring wells, hydrologists can accurately determine the specific flow direction and velocity of the groundwater. This information is vital for managing water resources,

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large-scale features. Plate tectonics explains how these mountain-building events occur across the Earth.

218. (D) It causes the initial movement of air from areas of high pressure to areas of low pressure.
In meteorology, the pressure gradient force is the fundamental driver of atmospheric motion. It arises from differences in air pressure between two geographic locations. This force pushes air directly from regions of higher pressure toward regions of lower pressure, initiating the movement that we perceive as wind. While other factors like the Coriolis force or friction influence the final speed and direction of the wind, the pressure gradient is the force responsible for starting the air's movement for equilibrium.

219. (A) La Nina
La Nina is a significant climate phenomenon characterized by a period of anomalously cool sea surface temperatures in the central and eastern tropical Pacific Ocean. It represents the cold phase of the El Nino-Southern Oscillation cycle. During La Nina, the trade winds become unusually strong, leading to increased upwelling of cold water in the east and pushing warm water further west. This shift has widespread impacts on global weather patterns, often leading to increased rainfall in some regions and unusually dry conditions in others.

220. (B) (Total amount of substance in the reservoir) / (Rate of input or output)
The concept of residence time provides a way to quantify how long a substance remains within a specific reservoir, such as a lake, the atmosphere, or an aquifer. It is calculated by dividing the total amount of the substance currently in the reservoir by the rate at which it enters or leaves, assuming the system is in a steady state. This value helps scientists understand the turnover rate and stability of different natural cycles, providing information for managing systems.

221. (C) Climate
Climate is the most influential factor in determining the type of soil that develops in a particular region. It dictates the intensity of weathering and biological activity. In a desert, low precipitation limits chemical weathering and organic accumulation, resulting in thin soils. Conversely, high temperatures and abundant rainfall of a tropical rainforest accelerate these processes, leading to deep, highly leached, and nutrient-poor soils. While parent rock and topography are important, the over arching influence of climate creates the primary differences.

222. (D) Settling and accumulation of transported sediment.
In the sedimentary cycle, deposition is the critical stage that follows the weathering, erosion, and transportation of rock fragments. It occurs when the energy of the transporting agent—such as a slowing river, a weakening wind, or a melting glacier—is no longer sufficient to carry the sediment load. As a result, the particles settle out and accumulate in a new location, forming layers of sediment. Over time, these layers can undergo burial and lithification to eventually become new sedimentary rocks.

223. (A) Both A and R are true and R is the correct explanation of A.
Siderophile elements, often called iron-loving, have a high chemical affinity for metallic iron. During the Earth's early history, the planet underwent primary geochemical differentiation while in a molten state. Gravity caused the densest materials, primarily metallic iron and nickel along with these siderophile elements, to sink toward the center to form the core. This separation process explains why elements like iron and nickel are concentrated in the center. Both the assertion and the reason are true and accurate.

224. (C) The Sahara Desert province
India's hydro geology is divided into several major provinces based on their geological characteristics and water potential. These include the highly productive alluvial Indo-Gangetic plains, the basaltic Deccan Trap province, and the complex Himalayan mountainous region. Each of these provinces plays a significant role in India's water resource management. In contrast, the Sahara Desert is located in northern Africa and is not a groundwater province of India. Identifying correct regional provinces is essential for understanding the specific water resources available.

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225. (A) P-4, Q-3, R-1, S-2
Earth and environmental sciences rely on several fundamental concepts to describe natural processes. Darcy's Law defines groundwater flow through porous media, while the Ghyben-Herzberg relation models the freshwater-saltwater interface in coastal regions. Cation exchange capacity is a key indicator of soil fertility and chemical behavior. Plate tectonics provides the theoretical framework for understanding the formation of mountains and oceans through crustal movement. Correctly matching these terms with their associated concepts is essential for understanding physical and chemical dynamics.

226. (B) Increased groundwater recharge rates
The excessive withdrawal of groundwater from an aquifer leads to several detrimental environmental effects, such as land subsidence, a lowering of the water table, and saltwater intrusion in coastal areas. These occur when extraction exceeds natural recharge. However, over-pumping does not increase groundwater recharge rates. Recharge is primarily determined by precipitation and infiltration from the surface. While lowering the water table might slightly increase the gradient for recharge in some cases, it is not a direct result of unsustainable use.

227. (B) A focus on sustainability, efficiency, and recycling.
A historical perspective on the conservation of non-renewable resources shows an evolution from simple extraction to a focus on long-term sustainability. This modern approach emphasizes the need for efficiency, waste reduction, and recycling to extend the availability of finite materials like minerals and fossil fuels. It also involves the search for sustainable alternatives. This shift recognizes that unchecked consumption is unsustainable and that responsible management is necessary to balance economic development with environmental health and the resource needs of generations.

228. (A) Wildfire
Geological hazards are those driven primarily by Earth's internal or surface geological processes, such as plate tectonics or mass wasting. Landslides, earthquakes, and volcanism all fit this definition. A wildfire, however, is primarily a biological and meteorological hazard, often triggered by lightning or human activity and fueled by vegetation and weather conditions. While wildfires interact with the landscape, they are not driven by geological forces in the same way as tectonic events, making them distinct from other hazards.

229. (B) Reduce the vulnerability of society to the impacts of natural events.
Natural hazard mitigation focuses on taking long-term actions to reduce the risks and negative impacts associated with disasters. The ultimate goal is to decrease the vulnerability of society to the effects of natural events like earthquakes or floods. This is achieved through resilient infrastructure, effective land-use planning, and public education. Mitigation does not aim to stop the natural processes themselves. Instead, it builds societal resilience to ensure that natural events do not turn into human disasters.

230. (C) Outgassing of volatile compounds from the Earth's interior.
The origin of the Earth's atmosphere is primarily attributed to the process of interior outgassing. During the planet's early geological history, intense volcanic activity released various volatile compounds, such as nitrogen, carbon dioxide, and water vapor, from the deep interior. These gases accumulated over time to form the planet's initial atmosphere. This process provided the necessary gaseous envelope to support environmental cycles and life development. Outgassing from volcanic eruptions was a fundamental step in Earth's early chemical evolution.

231. (D) A spatial physical quantity, such as gravity or magnetism.
A geophysical field is defined as a spatial physical quantity that exists throughout a region of space and can be measured and mapped by scientists. Common examples include the Earth's gravitational, magnetic, and thermal fields. These fields provide critical information about the planet's internal structure, dynamics, and composition. They are not physical locations like a park, but rather continuous mathematical and physical properties that influence everything from the motion of the core to compass orientations.

232. (A) Both Statement I and Statement II are true.

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The rock cycle is a fundamental concept illustrating the continuous transformation of Earth materials through various geological processes. It shows that any rock type—igneous, sedimentary, or metamorphic—can be converted into any other type over time. These transformations are driven by energy from two primary sources: the Earth's internal heat, which powers magmatism and metamorphism, and external energy from the Sun, which drives weathering and the hydrological cycle. Both statements are accurate, highlighting the dynamic nature of crustal processes.

233. (C) Mineral types affect swelling, shrinking, and fertility.
Identifying and characterizing clay minerals is essential in soil science because different mineral types exert a major influence on a soil's physical and chemical behavior. Specific clay minerals determine key properties like the cation exchange capacity, which affects fertility, and the capacity for water retention. Furthermore, some clays are expansive, meaning they swell and shrink significantly with moisture changes, which impacts soil stability for agriculture and construction. Understanding these mineral differences is necessary for evaluating soil health.

234. (B) Distribution or segregation between different coexisting phases, like melt and crystals.
In geochemistry, partitioning refers to the unequal distribution or segregation of a chemical element between two or more coexisting phases. This often occurs during geological processes such as the crystallization of magma into minerals, the dissolution of minerals into water, or the adsorption of ions onto solid surfaces. This segregation happens because different elements have varying chemical affinities for different phases. Understanding partitioning is critical for modeling the evolution of magmas, the formation of ore deposits, and Earth elements.

235. (B) 2, 1, 3
While the Earth's surface is mostly water, only a tiny fraction is freshwater. Among these freshwater reservoirs, ice caps and glaciers contain the largest volume, primarily in Antarctica and Greenland. Groundwater represents the second largest reservoir and is the largest source of liquid freshwater. Surface water in lakes and rivers, although vital for human life and ecosystems, accounts for the smallest volume of these three. Therefore, the correct order of decreasing volume for these freshwater sources is ice, groundwater, and lakes.

236. (D) Ease with which water can move through a porous medium.
Hydraulic conductivity is a fundamental parameter in hydro geology that quantifies the ease with which water can move through a porous medium, such as soil or fractured rock. It depends on both the permeability of the solid material and the viscosity of the water. This value is essential for applying Darcy's Law and for predicting the velocity and flow direction of groundwater in an aquifer. High conductivity allows water to flow rapidly, which is characteristic of productive aquifers.

237. (A) Increased risk of flooding from storm surges and high tides.
In coastal cities, land subsidence caused by excessive groundwater withdrawal has severe consequences. As the land surface sinks relative to sea level, the risk of inundation increases. This leads to a direct and significant increase in the potential for flooding during storm surges and high tides, as the natural and engineered defenses are no longer at their intended elevation. Subsidence can also damage infrastructure like buildings and roads, compounding the challenges of managing water in low-lying coastal environments.

238. (A) Both A and R are true and R is the correct explanation of A.
The prediction of natural hazards like floods and cyclones has seen substantial improvement due to scientific and technological progress. Advances in remote sensing, sophisticated computer modeling, and extensive monitoring networks now allow for more accurate tracking and forecasting of hazardous conditions. These tools enable meteorologists and hydrologists to issue earlier and more reliable warnings, providing critical time for at-risk populations to prepare or evacuate. Therefore, both the assertion and the reason are true and accurate.

239. (B) The rapid cooling of lava on the Earth's surface.

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essential for regulating the planet's chemistry and maintaining conditions suitable for supporting life.

273. (D) variable depending on the specific Earth reservoir being considered.
The abundance of any specific chemical element is not uniform across the planet but varies significantly depending on the reservoir being examined. Factors such as the element's chemical affinity and the processes occurring within the crust, hydrosphere, or biosphere determine its local concentration. Understanding these variations is crucial for classifying elements and interpreting the geochemical history of different parts of Earth.

274. (A) paleoclimate.
Gaining an understanding of how elements are partitioned and recycled through Earth's systems is vital for scientific research in several fields. Specifically, these geochemical principles are essential for interpreting paleoclimate records preserved in ancient sediments and ice cores. By analyzing the distribution of elements, scientists can reconstruct past environmental conditions and track how the Earth's climate has changed over time.

275. (C) the geochemical partitioning of elements.
Surficial geologic processes, including weathering and sedimentation, act as primary mechanisms for the geochemical partitioning of elements. As rocks break down and interact with water, different chemical components are selectively concentrated in either solid or fluid phases. This ongoing differentiation shapes the chemical characteristics of soils, sediments, and natural waters, directly influencing the formation of various mineral deposits globally.

276. (A) Hydraulic gradient and hydraulic conductivity
Darcy's Law is the fundamental principle used to describe the movement of groundwater through porous materials. It establishes that the rate of water flow is directly proportional to two key factors: the hydraulic gradient, which is the slope of the water table, and the hydraulic conductivity. This mathematical relationship allows hydrogeologists to calculate how quickly water moves through an aquifer.

277. (D) the ease with which water can move through a porous medium.
Hydraulic conductivity is a critical parameter in hydro geology that represents the ease with which water can move through the interconnected pore spaces or fractures of an aquifer. It depends on the physical properties of the geological material, such as grain size and porosity. A high conductivity indicates that water flows easily, while low conductivity suggests significant resistance to groundwater movement.

278. (B) High-velocity flow in cavernous formations
While Darcy's Law is widely applicable to groundwater studies, its validity is limited under certain physical conditions. Specifically, the law assumes laminar flow and may not hold true in environments characterized by high-velocity or turbulent flow regimes. Such conditions are often found in cavernous limestone formations or large fractures, where the linear relationship between flow rate and gradient breaks down.

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279. (C) To track the movement and velocity of groundwater
Hydrogeologists utilize groundwater tracers to gain precise information about the behavior of water moving beneath the Earth's surface. These tracers are specific substances added to the groundwater system that can be detected at various points over time. By tracking these substances, scientists can determine the actual flow paths, travel times, and velocities of water as it migrates through an aquifer.

280. (D) recharge and discharge.
Groundwater levels are not static but exhibit constant fluctuations based on the balance of water entering and leaving the system. Recharge occurs when precipitation or surface water infiltrates the ground to replenish the aquifer. Conversely, discharge occurs through natural springs or human activities like pumping. The dynamic interaction between these two processes determines the overall volume of stored groundwater.

281. (A) compaction of aquifer materials after excessive water removal.
Land subsidence is a severe environmental consequence of excessive groundwater extraction from certain geological environments. When

layers is poor, the upper mass can slide away suddenly. This instability is often exacerbated by factors like wind-driven snow accumulation, temperature changes, or physical disturbances. Understanding snowpack structure is essential for avalanche forecasting and safety.

247. (D) vulnerability
The overall impact of a natural hazard is not solely determined by the physical magnitude of the event itself. Instead, it is a combined function of the hazard and the vulnerability of the population exposed to it. Vulnerability refers to the susceptibility of a community to suffer damage and loss based on factors like infrastructure quality, economic resources, and preparedness. Even a relatively small hazard can lead to a major disaster if the affected population is highly vulnerable, making resilience building essential.

248. (A) A rock is an aggregate of one or more minerals.
A fundamental distinction in geology is that a rock is a solid, naturally occurring aggregate composed of one or more minerals or mineraloids. In contrast, a mineral is a single, homogenous substance with a specific chemical composition and an ordered internal atomic structure. Therefore, while a mineral represents the basic building block, a rock is the more complex material that forms the bulk of the Earth's crust. Most rocks are made up of several minerals interlocked through geological processes.

249. (B) The subduction of oceanic crust and its subsequent melting and volcanism.
Geochemical recycling occurs over a wide range of timescales. A prime example of this process on a long geological timescale is the cycle involving the subduction of oceanic crust. As tectonic plates move, dense oceanic crust is pushed into the mantle at subduction zones. This material eventually melts, potentially returning to the surface through volcanic eruptions to form new crust. This cycle moves elements from the surface deep into the interior and back again over millions of years.

250. (D) Statement I is false but Statement II is true.
Mitigation of natural hazards is a proactive strategy aimed at reducing the risks and negative consequences associated with events like earthquakes or floods. It is important to understand that mitigation does not seek to eliminate the natural hazard itself, as most geological and atmospheric processes are beyond human control. Instead, it focuses on building resilient communities and infrastructure to minimize the resulting damage and loss of life. Therefore, while the first statement is incorrect, the second statement accurately describes mitigation.

251. (B) Gravitational segregation by density
During the early stages of Earth's formation, intense heating led to a largely molten state. This fluidity allowed gravity to act as the primary driver for geochemical differentiation. Materials segregated based on their relative densities, where heavier metallic elements sank toward the center while lighter silicate materials rose to form the outer layers of the planet.

252. (A) Release of trapped gases from the interior
The creation of the early atmosphere resulted from the release of volatile compounds trapped within the planet's interior. As the young Earth underwent differentiation and intense volcanic activity, gases such as water vapor, carbon dioxide, and nitrogen were expelled through outgassing. These accumulated gases eventually formed the initial atmospheric layer surrounding the cooling planet before the hydrosphere developed.

253. (C) Core, Mantle, Crust, Atmosphere
The geochemical differentiation of Earth followed a specific chronological sequence based on density and cooling. Initially, heavy metals migrated inward to form the core, followed by the separation of the mantle and the solidification of the crust. Subsequently, volcanic outgassing created the primordial atmosphere, which later cooled enough for water vapor to condense and form the hydrosphere.

254. (D) The cooling of the planet and condensation of atmospheric water vapor
The development of the hydrosphere occurred as a secondary process following the establishment of the atmosphere. As the planet continued to lose heat, atmospheric water vapor reached a point of saturation and condensed. This led to massive precipitation, where liquid water

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290. (A) integrate exploitation with conservation and environmental mitigation.
A modern approach to managing natural resources requires a shift from unchecked exploitation toward a more balanced framework. This involves integrating the necessary extraction of materials with robust conservation strategies and efforts to mitigate environmental damage. By learning from historical mistakes, society can develop systems that support economic needs while ensuring long-term ecological health and the sustainability of vital non-renewable resources.

291. (C) high magnitude and low frequency.
Catastrophic geological hazards are extreme natural events that arise from internal or surface Earth processes. These hazards are typically characterized by a high magnitude, meaning they possess immense destructive power, and a low frequency, occurring relatively infrequently compared to smaller events. Despite their rarity, their potential for causing widespread devastation makes understanding their mechanisms essential for risk assessment and community safety.

292. (A) Tsunami
A tsunami is a natural hazard consisting of a series of powerful ocean waves generated by the sudden displacement of a large volume of water. This displacement is most commonly triggered by submarine earthquakes or underwater volcanic eruptions. As these waves travel toward shallow coastal areas, they increase in height and can cause catastrophic flooding and destruction upon reaching the shore.

293. (D) the sudden release of accumulated tectonic stress.
Earthquakes are geological events caused by the sudden release of energy in the Earth's lithosphere. This energy usually accumulates as stress along tectonic plate boundaries or geological faults over long periods. When the stress exceeds the strength of the rocks, they fracture or slip, sending out seismic waves that manifest as ground shaking, potentially leading to significant structural damage.

294. (B) An extreme and localized rainfall event
A cloud burst is defined as a highly localized and extreme meteorological event characterized by intense rainfall over a very short period. While it is a weather phenomenon, its impacts are often geological in nature, as the sudden deluge can trigger rapid flash floods and landslides. These events are particularly dangerous in mountainous regions where the terrain can accelerate the flow of water.

295. (C) Heavy rainfall and seismic activity
Landslides involve the rapid movement of rock, soil, and debris down a slope under the influence of gravity. The occurrence of these events is frequently linked to two primary triggers: heavy or prolonged rainfall and seismic activity from earthquakes. These factors reduce the stability of the slope material, causing it to fail and move downward, posing a threat to nearby infrastructure.

296. (D) Prediction aims to forecast an event, while mitigation aims to reduce its impact.
Prediction and mitigation represent two distinct strategies for managing natural hazards. Prediction focuses on the scientific task of forecasting the timing, location, and magnitude of a future event. In contrast, mitigation involves taking proactive steps to reduce or eliminate the long-term risks and impacts associated with such events. While prediction seeks to warn, mitigation aims to build resilience and minimize damage.

297. (A) Earthquakes
The ability of scientists to accurately forecast natural hazards varies significantly across different types of events. While flood and tsunami warning systems have seen substantial improvements, the precise short-term prediction of earthquakes remains a major scientific challenge. Despite ongoing research, it is currently impossible to consistently determine exactly when and where an earthquake will strike, making mitigation efforts even more crucial.

298. (B) A structural mitigation measure
Constructing a seawall to protect a coastal community from a tsunami is a clear example of a structural mitigation measure. This approach involves building infrastructure designed to block or dissipate the energy of incoming waves. By creating a physical barrier, these engineering

La Niña represents the cool phase of the El Niño-Southern Oscillation cycle and generally produces climatic effects that are the opposite of its warm counterpart. While El Niño tends to suppress rainfall, La Niña is typically associated with enhanced monsoon activity across India. This phase often brings surplus precipitation, which can increase the likelihood of floods in various regions.

265. (A) The strength of the monsoon and timing of western disturbances
The environmental rhythm and economic stability of the Indian subcontinent are heavily dependent on predictable climatic patterns. Significant challenges to water and food security arise from the inherent variability in the strength of the summer monsoon and the timing of western disturbances. Fluctuations in these systems can lead to unpredictable rainfall, causing either devastating droughts or destructive floods.

266. (B) Weathering is an in-situ breakdown, while erosion involves movement.
In geological processes, weathering refers specifically to the in-situ breakdown of rocks and minerals directly at the Earth's surface through physical and chemical reactions. In contrast, erosion involves the subsequent removal and movement of this fragmented material. While weathering decomposes the parent rock where it sits, erosion requires an agent like water or wind to transport the resulting sediments.

267. (B) mineralogical composition, especially clay minerals.
The Cation Exchange Capacity is a fundamental property that measures a soil's ability to hold and exchange positively charged ions. This capacity is primarily determined by the soil's mineralogical composition, specifically the presence of clay minerals. The layered structures and negative surface charges of these minerals provide the necessary sites for cation adsorption, directly influencing the soil's overall fertility.

268. (A) the deposition of weathered parent material.
Soil formation, also known as pedogenesis, begins after the initial breakdown of rocks through weathering and the subsequent movement of those materials. The process officially starts once weathered sediments are deposited, creating the parent material. From this foundation, factors such as climate, biological organisms, and topography work over time to transform the raw minerals into a structured and functional soil.

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269. (C) a high Cation Exchange Capacity.
A soil characterized by a high concentration of specific clay minerals typically exhibits a high Cation Exchange Capacity. Because clay particles possess significant surface areas and electrical charges, they effectively attract and hold essential nutrients in the form of cations. Consequently, the mineralogical makeup of the soil directly dictates its capacity to store the elements necessary for sustained plant growth.

270. (D) Weathering -> Erosion/Transportation/ Deposition -> Soil Formation
The development of soil properties follows a logical geological progression. It begins with the weathering of parent rocks into smaller fragments. These fragments undergo erosion, transportation, and eventual deposition by natural agents to form a base of parent material. Finally, the process of soil formation, or pedogenesis, occurs as environmental factors transform this deposited material into a functional and fertile soil.

271. (C) The differential distribution and concentration of elements between solid and fluid phases.
In the context of surficial geological processes, partitioning refers to the differential distribution of chemical elements between different physical states. During activities like weathering and sedimentation, some elements preferentially concentrate in solid mineral phases, while others become mobilized in fluid phases like water. This selective enrichment is a fundamental mechanism that drives the chemical evolution of the Earth's surface and water.

272. (B) movement of elements between the Earth's different reservoirs.
Geochemical recycling describes the continuous movement and exchange of chemical elements between the Earth's various reservoirs, including the crust, atmosphere, hydrosphere, and biosphere. Rather than being permanently stored in one location, elements follow complex physical, chemical, and biological pathways over geological timescales. This ongoing process is

collected in low-lying basins on the primitive crust, eventually creating the world's oceans and global water cycle.

255. (C) metallic; silicate
Geochemical partitioning during Earth's molten phase resulted in distinct chemical compositions for its structural layers. The core is primarily composed of heavy metallic elements like iron and nickel that sank during differentiation. In contrast, the crust consists of lighter, silicate-rich materials that floated to the surface. This separation established the fundamental chemical contrast between the planet's interior and exterior.

256. (B) Pressure gradient force
Air motion in the atmosphere is primarily triggered by the pressure gradient force, which arises from differences in atmospheric pressure between two locations. This force acts to move air directly from regions of higher pressure toward regions of lower pressure. Without this initial imbalance, other atmospheric forces would have no motion to act upon or modify during circulation.

257. (D) Pressure gradient force and Coriolis force
In the upper atmosphere, where frictional effects from the surface are negligible, air movement is governed by a specific equilibrium. A geostrophic wind field occurs when the pressure gradient force, which pushes air toward low pressure, is exactly balanced by the Coriolis force, which deflects motion. This balance results in winds that blow parallel to the isobars.

258. (A) deflect the path of moving air.
The rotation of the Earth creates an apparent deflective effect known as the Coriolis force. This force acts perpendicular to the direction of air movement, causing winds to turn right in the Northern Hemisphere and left in the Southern Hemisphere. It does not initiate motion or change wind speed directly but alters the trajectory of moving air masses globally.

259. (C) Closer to the Earth's surface
The influence of friction on atmospheric motion is most pronounced in the layers closest to the Earth's surface. At these lower altitudes, contact with terrain and obstacles slows wind speed and disrupts the balance between pressure gradient and Coriolis forces. This interference causes surface winds to cross isobars at an angle rather than flowing parallel to them.

260. (A) Pressure gradient force, Coriolis force, and frictional force
Gradient wind describes the complex flow of air around curved pressure systems, such as cyclones and anticyclones. This type of atmospheric motion accounts for the combined effects of the pressure gradient force, the Coriolis force, and frictional forces near the surface. Understanding these interactions is vital for predicting weather patterns and interpreting how air circulates within localized and global systems.

261. (D) A seasonal reversal of wind direction
The Indian monsoon is fundamentally defined by a large-scale, periodic reversal in the direction of prevailing winds. This seasonal shift is the primary driver for the majority of the subcontinent's annual rainfall. While other global phenomena influence its intensity, the core identity of the monsoon lies in this predictable change in wind patterns between the summer and winter seasons.

262. (B) Winter
Western disturbances are extratropical storms that originate in the Mediterranean region and travel eastward across the Middle East toward India. These systems primarily impact the northern parts of the subcontinent during the winter months. They are essential for bringing crucial moisture and precipitation to the region outside of the primary summer monsoon season, supporting agriculture and water resources.

263. (C) Weakened rainfall and potential drought
The El Niño-Southern Oscillation is a major ocean-atmosphere interaction that significantly modulates the performance of the summer monsoon. During an El Niño phase, characterized by warming in the central and eastern Pacific Ocean, the Indian monsoon often experiences weakened rainfall. This reduction in precipitation frequently leads to severe drought conditions, impacting the region's agricultural productivity and water security.

264. (D) opposite to that of El Niño.

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water is removed from an aquifer faster than it can be replenished, the fluid pressure within the pore spaces decreases. This leads to the physical compaction of the aquifer materials, causing the ground surface above to sink, which often results in infrastructure damage.

282. (B) freshwater and saline water in coastal aquifers.
The Ghyben-Herzberg relation is a physical principle used to describe the delicate balance between freshwater and saline water in coastal aquifer systems. It provides a mathematical way to estimate the depth of the saltwater interface based on the height of the freshwater column above sea level. This relationship is crucial for managing coastal water resources and preventing groundwater contamination.

283. (B) The saline water interface rises, contaminating the freshwater.
According to the Ghyben-Herzberg principle, a reduction in the freshwater head—the height of water above sea level—causes a significant upward movement of the underlying saline water. When excessive pumping lowers this head, the saltwater interface rises to fill the void. This process, known as saltwater intrusion, contaminates the freshwater supply and can make the aquifer unsuitable for human use.

284. (A) A lowering of the groundwater table
The most immediate and widespread effect of extracting groundwater at rates exceeding natural recharge is the progressive lowering of the water table. As the volume of stored water decreases, the depth to reach the water level increases. This depletion forces wells to be drilled deeper, significantly raises the energy costs associated with pumping, and can eventually lead to wells going dry.

285. (C) Saltwater intrusion
Groundwater quality is threatened by both human activity and the disruption of natural balances. While surface contaminants like industrial waste and agricultural runoff pose a major risk of pollution, saltwater intrusion is equally dangerous in coastal areas. Saltwater intrusion occurs when over-pumping allows saline water to invade freshwater aquifers, permanently degrading the water quality and threatening the sustainability of water resources.

286. (D) short-term economic gains from exploitation.
Historically, the management and utilization of natural resources have been driven by a focus on immediate economic benefits. This approach emphasized the rapid exploration and exploitation of materials like minerals and fossil fuels to fuel industrial growth and development. However, this prioritization of short-term gains often overlooked the long-term environmental consequences and the finite nature of the resources being extracted.

287. (C) finite and cannot be replenished on human time scales.
The increasing emphasis on the conservation of non-renewable resources stems from the fact that these materials are finite. Unlike renewable resources, minerals and fossil fuels are formed over millions of years and cannot be replenished on a human time scale once they are consumed. Conservation strategies are therefore necessary to ensure that these limited supplies remain available for use by future generations.

288. (B) Pollution and habitat destruction
The extraction and exploitation of natural resources are linked to several significant environmental issues. Common concerns include the destruction of natural habitats, which threatens biodiversity, and the pollution of local air and water supplies. Additionally, mining activities often lead to extensive landscape degradation. These impacts highlight the need for more sustainable management practices that balance economic development with environmental protection.

289. (D) the wise and sustainable use of resources.
Conservation is defined not as the complete cessation of resource use, but as the wise and sustainable management of available materials. This approach involves improving efficiency, reducing unnecessary consumption, and promoting the recycling of materials to extend the life of finite resources. The goal is to meet current needs without compromising the ability of future generations to meet their own requirements.

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Extrusive igneous rocks, such as basalt, are formed when molten rock reaches the Earth's surface as lava. Because the surface environment is much cooler than the interior, the lava cools and solidifies very rapidly. This fast cooling rate prevents large crystals from growing, resulting in a fine-grained or even glassy texture. This process is distinct from the formation of intrusive rocks, which cool slowly deep underground, making rapid surface cooling the defining characteristic of extrusive volcanic formations.

240. (B) 1, 2 and 4
Atmospheric movement is controlled by several key forces. The pressure gradient force initiates air flow toward low pressure, while the Coriolis force deflects moving air due to the Earth's rotation. A geostrophic wind occurs when these two forces are in balance. However, frictional force is strongest near the surface and decreases with altitude. Furthermore, the Coriolis force is actually zero at the equator and strongest at the poles. Therefore, the first, second, and fourth statements are correct.

241. (D) Weathering is rock breakdown; erosion is the transport.
In geology, a clear distinction is made between weathering and erosion. Weathering refers to the physical and chemical processes that break down rocks and minerals in place, or in-situ, at the Earth's surface. In contrast, erosion is the subsequent process involving the physical removal and transport of these weathered fragments by agents like water, wind, or ice. While they often occur together and are closely related, weathering focuses on the breakdown, whereas erosion focuses on movement and landscape redistribution.

242. (A) It indicates the soil can retain and supply more essential plant nutrients.
A high Cation Exchange Capacity is considered a major benefit for agriculture because it serves as a measure of the soil's ability to retain and supply essential plant nutrients. These nutrients, such as calcium, magnesium, and potassium, are held on the negative surfaces of clay and organic matter. A higher capacity means the soil acts as a more effective reservoir, preventing vital minerals from being leached away by rainfall while keeping them available for plants to absorb.

243. (C) Dendroclimatology
Dendroclimatology is the specialized field of science that uses tree rings to reconstruct past climate conditions. Because trees grow more in favorable years and less in unfavorable ones, the thickness and density of their annual rings provide a record of historical temperatures and precipitation levels. By analyzing overlapping tree records, scientists can look back hundreds or even thousands of years. This proxy data is essential for understanding long-term climate variability and provides a context that extends beyond modern records.

244. (D) Turbulent flow rate relations become non-linear.
Darcy's Law provides a linear relationship between the groundwater flow rate and the hydraulic gradient. This model is only valid under laminar flow conditions, where fluid moves smoothly in parallel layers. In natural systems, as the velocity of the water increases, the flow can eventually become turbulent. At this point, the relationship between the flow rate and the driving force becomes non-linear, meaning Darcy's Law no longer provides accurate predictions. This restriction is necessary because fundamental relations change.

245. (C) Because they are finite, and their formation takes geological time scales.
The conservation of non-renewable resources like copper and zinc is essential because these materials are finite and their formation requires complex geological processes occurring over millions of years. Unlike biological resources, once they are extracted and consumed, they cannot be replenished on any human time scale. As industrial demand grows, the limited availability of these minerals becomes a significant concern. Judicious management, recycling, and efficient use are necessary to ensure these materials remain available for both current and future generations.

246. (B) A rapid accumulation of new snow on an existing weak snow layer.
While several factors can trigger an avalanche, the most common cause is the rapid accumulation of new snow on top of an existing, weak snow layer. This added weight increases the stress on the snowpack, and if the bond between the

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solutions aim to reduce the vulnerability of human settlements to powerful and potentially destructive natural events.

299. (B) Implementing land-use zoning regulations
Non-structural mitigation refers to policies and regulations that reduce hazard risks without physical construction. Implementing land-use zoning regulations is a primary example of this strategy, as it prevents development in high-risk areas like floodplains or landslide zones. Other examples include establishing building codes and conducting public education to ensure that communities are better prepared for inevitable natural events.

300. (A) To reduce the vulnerability and risk from hazard impacts.
The ultimate goal of mitigation is to foster the development of resilient communities that are less vulnerable to the destructive effects of natural hazards. Since many geological events cannot be prevented, mitigation focuses on minimizing the potential loss of life and property damage. Through various structural and non-structural actions, these measures aim to reduce overall societal risk.

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(C) Pyrolysis
(D) Direct combustion

57. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : Nuclear fusion reactions require extremely high temperatures and pressures to initiate.
Reason (R) : Overcoming the electrostatic repulsion between positively charged nuclei to allow them to fuse requires immense kinetic energy.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

58. Which characteristic of solar radiation is most critical for designing and evaluating solar energy systems?
(A) Its observable color
(B) Its intensity and spectral distribution
(C) Its specific magnetic properties
(D) Its distinctive smell

59. The highest rank of coal, known for its high carbon content and low volatile matter, is:
(A) Lignite
(B) Peat
(C) Anthracite
(D) Bituminous

60. Consider the following statements about fossil fuels:
(a) They are considered renewable resources on a human timescale.
(b) They are formed from the anaerobic decomposition of dead organisms.
(c) Their combustion releases energy stored for millions of years.
(d) They include materials like coal, petroleum, and natural gas.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (b), (c), and (d)
(C) (a), (c), and (d)
(D) (a), (b), and (d)

61. What is the principle behind a solar pond's ability to store heat?
(A) A reflective bottom layer directs all heat to a central collector.
(B) A salinity gradient prevents convection, trapping heat in the lower, denser layers.
(C) The water is replaced with a fluid that has a high specific heat capacity.
(D) The pond is covered with a glass sheet, creating a strong greenhouse effect.

62. The net-calorific value (NCV) is a more practical measure of the useful energy available from a fuel in many applications because:
(A) It accounts for the energy used to mine and transport the fuel.
(B) The exhaust gases in many systems leave at high temperatures, preventing water vapor from condensing.
(C) It is consistently a higher value than the gross-calorific value in all tests.
(D) It includes the energy content of non-combustible ash and mineral impurities.

63. Which part of the solar spectrum is primarily responsible for the heating effect of sunlight?
(A) Ultraviolet (UV)
(B) Visible light
(C) Infrared (IR)
(D) X-rays

64. Match List I with List II regarding nuclear reactor components and their functions.
List I: (Nuclear Reactor Component)
P. Fuel Rods
Q. Moderator
R. Control Rods
S. Coolant
List II: (Function)
1. Regulates the chain reaction
2. Contains fissile material
3. Transfers heat
4. Slows down neutrons
Choose the correct option:
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-4, Q-1, R-2, S-3

65. The primary environmental concern with Coal Bed Methane (CBM) extraction is:

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(A) Coal is primarily composed of carbon, hydrogen, oxygen, and various mineral impurities.
(B) Petroleum is a complex mixture of hydrocarbons of varying molecular weights.
(C) Natural gas is almost exclusively composed of carbon dioxide.
(D) The composition of fossil fuels varies depending on their origin and geological history.

10. Consider the following statements about Gas Hydrates:
(a) They are crystalline solids of water and natural gas.
(b) The most common gas trapped is methane.
(c) They are typically found in deep oceanic sediments and permafrost regions.
(d) They are a form of liquid fossil fuel.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (a), (b), and (d)
(C) (a), (c), and (d)
(D) (b), (c), and (d)

11. Gross-calorific value (GCV) differs from Net-calorific value (NCV) because GCV includes the heat of:
(A) Complete combustion of sulfur content
(B) Thermal fusion of ash during combustion
(C) Evaporation of fuel before combustion
(D) Condensation of water vapor produced during combustion

12. The generation of hydro-power is based on which fundamental principle?
(A) Converting chemical energy into mechanical energy through fuel combustion.
(B) Converting potential energy of stored water into kinetic and then electrical energy.
(C) Converting nuclear energy into electrical energy using controlled atomic fission.
(D) Converting thermal energy into electrical energy using pressurized steam cycles.

13. Which of the following statements best describes Coal Bed Methane (CBM)?
(A) A synthetic gas produced from coal gasification.
(B) A liquid fuel derived from heating coal deposits.
(C) A form of natural gas extracted from coal seasons.
(D) The gas released during the burning of coal in power plants.

14. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : The Net-calorific value (NCV) of a fuel is always lower than its Gross-calorific value (GCV).
Reason (R) : During the combustion of fuel containing hydrogen, water vapor is formed, and the latent heat of vaporization of this water is not recovered in the case of NCV.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

15. What is the primary source of energy for tidal power generation?
(A) The gravitational pull of the Moon and the Sun
(B) The Earth's internal heat from radioactive decay
(C) The kinetic energy of wind across the ocean surface
(D) The temperature difference in ocean depth layers

16. Ocean Thermal Energy Conversion (OTEC) technology utilizes which of the following to generate electricity?
(A) The kinetic energy of ocean waves at the surface level
(B) The temperature difference between deep and shallow ocean water
(C) The salinity gradient between freshwater and seawater in estuaries
(D) The high pressure at the bottom of the deep ocean floor

17. Which of the following statements about different energy sources is incorrect?
(A) Wind power generation relies on the movement of air masses across the landscape.
(B) Hydro-power can only be generated from

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CHAPTER 05

Energy and Environment

1. Which of the following is considered the ultimate source of energy for most processes on Earth?
(A) Geothermal heat
(B) The Sun
(C) Nuclear fission
(D) Fossil fuels

2. The spectral characteristics of solar radiation are typically divided into which three major bands?
(A) Ultraviolet, Visible, Infrared
(B) Alpha, Beta, Gamma
(C) Microwave, Radio wave, Infrared
(D) Short-wave, Medium-wave, Long-wave

3. Identify the correct statement regarding solar radiation.
(A) All solar radiation reaching the top of the atmosphere penetrates to the Earth's surface without loss.
(B) The Earth's atmosphere is completely transparent to all wavelengths of incoming solar radiation.
(C) Solar radiation is subject to absorption and scattering as it passes through the atmosphere.
(D) The spectral distribution of solar energy is uniform across all wavelengths and does not vary.

4. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : The sun is the primary source of energy for the Earth's climate system.
Reason (R) : Solar radiation provides the energy that drives atmospheric circulation, the hydrological cycle, and sustains life.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

5. What is the classification of fossil fuels primarily based on?
(A) Their specific geographical location and depth
(B) The era in which they were first discovered
(C) Their physical state (solid, liquid, or gas)
(D) Their observable color and distinctive odor

6. Which of the following is NOT a primary fossil fuel?
(A) Coal
(B) Uranium
(C) Petroleum
(D) Natural Gas

7. Match List I with List II regarding fossil fuels and their constituents.
List I: (Fossil Fuel)
P. Natural Gas
Q. Coal
R. Petroleum
S. Shale oil
List II: (Primary Constituent)
1. Complex mixture of hydrocarbons
2. Solid carbonaceous material
3. Kerogen
4. Methane
Choose the correct option:
(A) P-4, Q-2, R-1, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-4, R-1, S-3

8. The energy content of a fuel is commonly expressed by its:
(A) Calorific value
(B) Density
(C) Viscosity
(D) Ash content

9. Identify the incorrect statement about the composition of fossil fuels.

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(D) Organic matter, known as biomass.

28. Which of the following is a common method to produce energy from biomass?
(A) Nuclear fission
(B) Direct combustion
(C) Photovoltaic conversion
(D) OTEC

29. The most significant environmental implication associated with the widespread use of fossil fuels is:
(A) The alteration of ocean tides and coastal currents.
(B) The production of radioactive waste and byproducts.
(C) The emission of greenhouse gases like CO2
(D) The depletion of the ozone layer by methane gas.

30. In the context of global emissions, 'radiative forcing' refers to:
(A) The total physical force exerted by solar wind on the planetary magnetosphere.
(B) The net gravitational force causing the periodic movement of ocean tides.
(C) The mechanical force required to extract fossil fuels from the deep ground.
(D) The difference between the incoming solar energy absorbed by the Earth and the energy radiated back to space.

31. Which of the following statements about energy use patterns is generally true?
(A) Historically, developed countries have contributed a larger share of cumulative CO_2 emissions than developing countries.
(B) Developed countries typically have a lower per capita energy consumption than most developing nations.
(C) India's per capita energy consumption currently ranks among the highest of all nations in the world.
(D) Renewable energy sources currently constitute the majority of the total global energy mix.

32. The large-scale exploitation of hydropower, while renewable, can have significant environmental impacts, such as:
(A) Emission of large quantities of CO2 and SO_2 during operation.
(B) Habitat destruction and alteration of river ecosystems.
(C) Production of long-lived radioactive waste.
(D) High levels of noise pollution affecting urban areas.

33. Which of the following is a potential negative environmental impact of large-scale solar farms?
(A) Increased global warming due to high direct heat absorption.
(B) Large land area requirement, potentially impacting ecosystems and land use.
(C) Emission of greenhouse gases during the electricity generation phase.
(D) Disruption of migratory patterns of various marine and aquatic animals.

34. A major concern associated with nuclear energy is:
(A) The management and disposal of radioactive waste.
(B) The emission of carbon dioxide during plant operation.
(C) The depletion of stratospheric ozone.
(D) The contribution to acid rain.

35. The physico-chemical characteristics of petroleum are important for:
(A) Determining its exact age using carbon dating methods.
(B) Predicting earthquakes in the region of its extraction.
(C) Its refinement into various products like gasoline and diesel.
(D) Understanding its role in the process of photosynthesis.

36. Which of the following is a key component in a wind power generation system?
(A) A boiler
(B) A photovoltaic cell
(C) A nuclear reactor core
(D) A turbine with blades

37. Consider the following statements about the environmental implications of energy use:
(a) The burning of fossil fuels is a major contributor to global warming.
(b) Large hydropower projects can lead to

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(C) Nuclear Fusion
(D) Radioactive Decay

75. The term energy content of a fuel is synonymous with its:
(A) Calorific value
(B) Density
(C) Ignition temperature
(D) Flash point

76. All of the following are direct environmental implications of fossil fuel use EXCEPT:
(A) Release of CO_2 into the atmosphere.
(B) Acid rain from SOx and NOx emissions.
(C) Improved biodiversity in mining areas.
(D) Particulate matter pollution in the air.

77. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : Large-scale wind farms can have negative impacts on local wildlife, particularly birds and bats.
Reason (R) : The rotating blades of wind turbines can cause fatal collisions with flying animals.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

78. The primary difference between coal and petroleum in terms of their physical state at normal conditions is:
(A) Coal is a solid, petroleum is a liquid.
(B) Coal is a gas, petroleum is a solid.
(C) Both are liquids of different viscosities.
(D) Coal is a liquid, petroleum is a gas.

79. What principle allows a hydro-power plant to generate electricity?
(A) The conversion of thermal energy to mechanical energy via steam.
(B) The conversion of gravitational potential energy to kinetic energy, then to electrical energy.
(C) The conversion of chemical energy to electrical energy via batteries.
(D) The conversion of nuclear energy to mechanical energy via fission.

80. Which of the following statements about bioenergy is incorrect?
(A) Biomass is a renewable energy source for power.
(B) The combustion of biomass releases carbon dioxide.
(C) The process of creating bioenergy requires nuclear fission.
(D) Bioenergy is derived from recently living organic materials.

81. A key environmental challenge in the large-scale exploitation of geothermal energy can be:
(A) The emission of dissolved gases like hydrogen sulfide (H_2S).
(B) The consumption of large quantities of fossil fuels for plants.
(C) The production of high-level radioactive waste as a byproduct.
(D) The significant alteration of local wind patterns in the area.

82. The increasing concentration of CO_2 in the atmosphere leads to an enhancement of the natural greenhouse effect, which is the primary driver of:
(A) Ozone layer depletion
(B) Global warming
(C) The formation of polar stratospheric clouds
(D) The shifting of tectonic plates

83. Which of the following statements best describes the energy use pattern in India compared to a highly developed country like the USA?
(A) India has a higher total energy consumption but lower per capita consumption.
(B) India has both higher total and higher per capita energy consumption.
(C) India has a lower total energy consumption but higher per capita consumption.
(D) India has both lower total and lower per capita energy consumption.

84. The function of a coolant in a nuclear reactor is to:
(A) Absorb neutrons to control the reaction rate effectively.
(B) Slow down the fast neutrons produced by fission reactions.

(D) Chemical energy

47. Arrange the following events in the generation of hydropower in chronological order:
(i) Water turns the turbine blades.
(ii) Water is stored at a height in a dam.
(iii) The generator produces electricity.
(iv) Water flows through a penstock.
Select the correct sequence:
(A) (ii), (iv), (i), (iii)
(B) (i), (ii), (iii), (iv)
(C) (ii), (iii), (i), (iv)
(D) (iv), (ii), (i), (iii)

48. The term 'kerogen' is most closely associated with the formation of:
(A) Shale oil
(B) Coal Bed Methane
(C) Natural gas
(D) Gas hydrates

49. A major challenge for the large-scale implementation of tidal energy is:
(A) Its high carbon dioxide emissions during operation.
(B) Its dependence on clear, sunny weather conditions.
(C) Limited number of suitable sites with high tidal ranges.
(D) The radioactive waste it produces as a byproduct.

50. Consider the following statements about global CO_2 emissions:
(a) Developing countries, as a group, currently have higher total annual emissions than developed countries.
(b) On a per capita basis, emission levels in developed countries are generally much higher than in developing countries like India.
(c) India is the world's single largest emitter of CO_2, both historically and currently.
(d) Historical emissions from developed countries are a major reason for the current concentration of CO_2 in the atmosphere.
(e) All countries in the world have legally binding emission reduction targets.
Which of the above statements are correct?
(A) (a), (b), and (d)
(B) (a), (c), and (e)
(C) (b), (c), and (d)
(D) (a), (b), and (e)

51. What does the term physico-chemical characteristics of a fossil fuel refer to?
(A) Only its chemical formula and exact atomic weight.
(B) Its physical properties like density and boiling point, and its chemical properties like reactivity and composition.
(C) The specific geographical location and depth at which it is found.
(D) Its current market price and overall economic viability for trade.

52. The primary working fluid in a geothermal power plant is often:
(A) Concentrated molten salt
(B) Unrefined crude oil
(C) Steam or hot water from underground reservoirs
(D) Liquefied natural gas

53. Identify the incorrect pair.
(A) Solar collector - Thermal energy
(B) Photo-voltaic module - Electrical energy
(C) Wind turbine - Chemical energy
(D) Hydro-power dam - Potential energy

54. The process of converting solid biomass into a combustible gas mixture (syngas) is known as:
(A) Gasification
(B) Photosynthesis
(C) Nuclear fission
(D) Hydrolysis

55. Global warming is the long-term heating of Earth's climate system primarily due to human activities such as fossil fuel burning, which increases heat-trapping greenhouse gas levels. This increased trapping of heat is directly related to which concept?
(A) Ozone depletion
(B) Magnetic field reversal
(C) Radiative forcing
(D) Acid rain

56. All of the following are methods to produce energy from biomass EXCEPT:
(A) Anaerobic digestion
(B) Nuclear fusion

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displacement of communities.
(c) Wind turbines can pose a risk to avian populations (birds).
(d) Nuclear power plants produce no greenhouse gas emissions during their operation.

Which of the above statements are correct?
(A) (a) and (d) only
(B) (a), (b), and (c) only
(C) (b), (c), and (d) only
(D) (a), (b), (c), and (d)

38. The energy content of natural gas is primarily determined by its concentration of:
(A) Ethane
(B) Methane
(C) Propane
(D) Butane

39. What is the fundamental difference between nuclear fission and fusion?
(A) Fusion splits atoms; fission combines them.
(B) Fission is a chemical reaction; fusion is a physical one.
(C) Fusion is used in current power plants; fission is experimental.
(D) Fission splits atoms; fusion combines them.

40. Match List I with List II regarding energy sources and their principles.
List I: (Energy Source)
P. Geothermal Energy
Q. Solar Photovoltaic
R. OTEC
S. Wind Energy
List II: (Underlying Principle/Component)
1. Temperature gradient in ocean
2. Kinetic energy of air
3. Earth's internal heat
4. Photoelectric effect
Choose the correct option:
(A) P-3, Q-4, R-1, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

41. Which of the following is an example of a biomass feedstock for bioenergy production?
(A) Crude oil from underground reserves
(B) Natural gas in gaseous form
(C) Agricultural crop residue
(D) Uranium ore from mining sites

42. What is the role of control rods in a nuclear reactor?
(A) To regulate the rate of fission by absorbing neutrons
(B) To initiate the nuclear reaction in the core
(C) To transfer heat from the core to the coolant
(D) To convert thermal energy into electrical energy

43. Which statement is incorrect regarding the impacts of large-scale exploitation of wind energy?
(A) It requires significant land area.
(B) It can cause visual and noise pollution.
(C) It can interfere with bird and bat migratory routes.
(D) It produces substantial CO_2 emissions during operation.

44. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : The energy use pattern in developed countries is characterized by high per capita consumption.
Reason (R) : Industrialization, high levels of motorization, and an affluent lifestyle in developed countries lead to greater energy demand.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

45. The composition of coal is often analyzed in terms of its proximate analysis, which includes all of the following EXCEPT:
(A) Moisture content of the fuel
(B) Volatile matter within coal
(C) Hydrocarbon structure
(D) Ash content of the sample

46. What type of energy is being harnessed in a solar pond?
(A) Thermal energy
(B) Kinetic energy
(C) Nuclear energy

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(A) The release of methane, a potent greenhouse gas, into the atmosphere.
(B) The production of long-lived radioactive byproducts during the process.
(C) The potential for large-scale land subsidence in the extraction region.
(D) The disruption of marine ecosystems and deep-sea aquatic life forms.

66. What is the most abundant hydrocarbon in natural gas?
(A) Ethane (C_2H6)
(B) Methane (CH4)
(C) Propane (C3H8)
(D) Butane (C4H10)

67. The spectral characteristics of solar radiation refer to:
(A) The total amount of energy received from the sun.
(B) The distribution of energy across different wavelengths.
(C) The angle at which sunlight strikes the Earth's surface.
(D) The daily and seasonal variations in sunlight levels.

68. Which of these energy conversion devices works on the principle of the photovoltaic effect?
(A) Solar collector
(B) PV module
(C) Solar pond
(D) Wind turbine

69. In the context of energy, what are gas hydrates often referred to as?
(A) Liquid coal
(B) Burning ice
(C) Solid oil
(D) Gaseous rock

70. Consider the following energy sources:
(i) Coal
(ii) Wind
(iii) Solar
(iv) Natural Gas
Arrange them in descending order of their direct CO_2 emissions per unit of energy produced during operation.
(A) (i), (iv), (iii), (ii)
(B) (i), (iv), (ii), (iii)
(C) (iv), (i), (ii), (iii)
(D) (ii), (iii), (iv), (i)

71. The difference between Gross-calorific value and Net-calorific value is the latent heat of vaporization of:
(A) The fuel itself during the combustion process.
(B) The moisture present in the fuel and water formed from hydrogen combustion.
(C) The air used for combustion within the furnace.
(D) The carbon dioxide formed during the combustion process.

72. What is the fundamental requirement for generating power using OTEC (Ocean Thermal Energy Conversion)?
(A) A strong and consistent ocean current throughout the year.
(B) A significant temperature difference between surface and deep ocean water.
(C) A large tidal range between high and low sea levels.
(D) High-velocity winds near the ocean surface at all times.

73. Consider the following statements about nuclear reactors:
(a) A nuclear reactor is a device to initiate and control a self-sustained nuclear chain reaction.
(b) Boiling Water Reactors (BWRs) allow water to boil directly in the reactor core.
(c) Fusion reactors are currently the most common type used for commercial power generation.
(d) Control rods are typically made of neutron-absorbing materials like cadmium or boron.
(e) A nuclear reactor's main purpose is to create new elements.
Which of the above statements are correct?
(A) (a), (b), and (d)
(B) (a), (c), and (e)
(C) (b), (d), and (e)
(D) (a), (c), and (d)

74. The energy of the sun is a result of which process occurring in its core?
(A) Nuclear Fission
(B) Chemical Combustion

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fast-flowing rivers, not from stored water in dams.
(C) Geothermal energy taps into the heat stored within the Earth's crustal layers.
(D) Solar ponds use a salinity gradient to trap solar heat in concentrated layers.

18. What is the primary principle behind the functioning of a photo-voltaic module?
(A) The photoelectric effect
(B) The thermoelectric effect
(C) The principle of thermal expansion
(D) The principle of chemical combustion

19. Solar collectors are primarily designed to:
(A) Convert sunlight directly into electricity via semiconductor materials.
(B) Store solar energy in a stable chemical form for later use.
(C) Absorb solar radiation and transfer it as heat to a fluid.
(D) Reflect sunlight to a central point for aesthetic and visual purposes.

20. Arrange the following ranks of coal in increasing order of their carbon content:
(i) Peat
(ii) Lignite
(iii) Anthracite
(iv) Bituminous
Select the correct sequence:
(A) (i), (ii), (iv), (iii)
(B) (iv), (iii), (ii), (i)
(C) (i), (iv), (ii), (iii)
(D) (ii), (i), (iii), (iv)

21. The process of nuclear fission involves:
(A) The combining of two light nuclei to form a heavier nucleus structure.
(B) The spontaneous decay of a nucleus by emitting alpha particle radiation.
(C) The splitting of a heavy nucleus into two or more lighter nuclei.
(D) The conversion of a proton into a neutron within a stable atomic nucleus.

22. Nuclear fusion is the process that powers:
(A) Conventional nuclear power plants
(B) The Sun and other stars
(C) Geothermal vents
(D) The decay of radioactive isotopes

23. Consider the following statements about Shale oil:
(a) It is a conventional crude oil found in shale formations.
(b) It is an unconventional oil produced from oil shale rock fragments.
(c) The organic matter within the rock is called kerogen.
(d) Extraction requires heating the rock (pyrolysis).
(e) It can be pumped directly from the ground without any processing.
Which of the above statements are correct?
(A) (a), (c), and (e)
(B) (b), (c), and (d)
(C) (a), (d), and (e)
(D) (b), (d), and (e)

24. A common nuclear fuel used in most of the world's nuclear reactors is:
(A) Enriched Uranium (U-$_2$35)
(B) Heavy Deuterium isotopes
(C) Refined Thorium-$_2$3$_2$ fuel
(D) Synthetic Graphite-1$_2$ rods

25. What is the primary function of a moderator in a nuclear reactor?
(A) To absorb excess neutrons and control the chain reaction rate.
(B) To transfer heat away from the reactor core via a cooling fluid.
(C) To slow down fast neutrons to increase the probability of fission.
(D) To provide structural support for the fuel rods in the core.

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26. Which of the following is NOT a major type of nuclear reactor?
(A) Internal Combustion Reactor (ICR)
(B) Pressurized Water Reactor (PWR)
(C) Boiling Water Reactor (BWR)
(D) Gas Cooled Reactor (GCR)

27. The term 'Bioenergy' refers to energy derived from:
(A) The heat of the Earth's core from thermal decay.
(B) The splitting of atoms within a controlled reactor.
(C) The movement of ocean tides driven by lunar gravity.

(C) Remove heat from the reactor core to generate steam and prevent overheating.
(D) Provide the fissile material needed for the sustained chain reaction.

85. Which of the following is NOT a method for producing energy from biomass?
(A) Direct combustion in a furnace
(B) Gasification to produce syngas
(C) Pumping it directly into a gasoline engine
(D) Anaerobic digestion to produce biogas

86. Identify the correct pair from the following:
(A) Petroleum - Primarily Methane gas
(B) Coal - Solid carbonaceous rock
(C) Natural Gas - Liquid hydrocarbon mixture
(D) Shale Oil - Gaseous fuel trapped in ice

87. Which of the following statements correctly describes a principle of nuclear energy?
(A) Nuclear fusion involves splitting a heavy, unstable nucleus.
(B) Nuclear fission releases energy by converting a small amount of mass into energy, according to $E=mc^2$.
(C) Nuclear fuels like Uranium-235 undergo spontaneous combustion in air.
(D) Nuclear reactors operate without producing any physical waste products.

88. A flat-plate solar collector is a device that:
(A) Concentrates sunlight onto a small area using mirrored surfaces.
(B) Uses a dark-colored plate to absorb sunlight and heat a fluid.
(C) Converts sunlight directly into electricity via silicon cells.
(D) Stores solar energy in a saline solution for cooling purposes.

89. Tidal energy generation is most efficient in locations with:
(A) High and consistent wind speeds.
(B) A large difference between high tide and low tide.
(C) Deep ocean trenches with cold water.
(D) Abundant and direct sunlight throughout the year.

90. Consider the following statements regarding the characteristics of fossil fuels:
(a) Natural gas has a higher energy content per unit mass than coal.
(b) The composition of petroleum varies significantly based on its geographic origin.
(c) Anthracite coal has a higher carbon content than lignite.
(d) All fossil fuels have identical physico-chemical characteristics.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (a) and (d) only
(C) (b), (c), and (d)
(D) (a), (c), and (d)

91. Which of the following is a key advantage of nuclear fusion over nuclear fission as a potential energy source?
(A) Fusion produces more long-lived radioactive waste than fission.
(B) The fuel for fusion (deuterium, tritium) is more widely available and abundant than uranium.
(C) Fusion reactors are simpler and cheaper to build than fission reactors.
(D) Fusion reactions can be easily started and stopped at will.

92. The energy use pattern in developing countries is often characterized by:
(A) A growing demand for energy driven by industrialization and population growth.
(B) A heavy reliance on advanced and experimental nuclear technologies.
(C) A consistently high per capita consumption of energy across all sectors.
(D) A primary focus on energy conservation over any new production.

93. The impact of large-scale exploitation of solar energy on land use is a significant consideration because:
(A) Solar farms can require large areas of land, which may compete with agriculture or natural habitats.
(B) Solar panels release toxic chemicals into the soil during operation.
(C) Solar energy generation causes significant ground vibrations.
(D) The operation of solar farms drastically lowers the local air temperature.

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94. What is the main reason for the difference in CO_2 emissions between developed and developing countries on a historical basis?
(A) Developing countries have always used more efficient technologies.
(B) Developed countries have much larger populations.
(C) Developed countries started the industrial revolution much earlier and have been burning fossil fuels for a longer period.
(D) Developing countries rely more on nuclear energy.

95. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : Radiative forcing is a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system.
Reason (R) : An increase in atmospheric CO_2 concentration results in a positive radiative forcing, leading to a warming effect.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

96. The main purpose of refining petroleum is to:
(A) Separate the crude oil into various components with different boiling points.
(B) Increase its carbon content to make it a solid fuel.
(C) Remove all hydrogen from the hydrocarbons.
(D) Convert it into natural gas through a chemical process.

97. Match List I with List II regarding energy technologies and environmental impacts.
List I: (Energy Technology)
P. Large-scale Hydro-power
Q. Fossil Fuel Combustion
R. Nuclear Power
S. Large-scale Wind Farm
List II: (Key Environmental Impact)
1. Radioactive waste disposal
2. Avian mortality (bird deaths)
3. Greenhouse gas emissions
4. River ecosystem disruption
Choose the correct option:
(A) P-3, Q-2, R-1, S-4
(B) P-4, Q-3, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-4, S-1

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98. Which one of the following is NOT a type of nuclear reactor?
(A) Pressurized Water Reactor (PWR)
(B) Heavy Water Reactor (CANDU)
(C) Light Water-Graphite Reactor (RBMK)
(D) Petroleum Cracking Reactor (PCR)

99. The sun's energy reaching the Earth is a form of:
(A) Electromagnetic radiation
(B) Geothermal energy
(C) Chemical energy
(D) Acoustic energy

100. Consider the following steps of energy production in a typical coal-fired power plant:
(i) Steam turns a turbine.
(ii) Coal is combusted in a boiler to heat water.
(iii) The turbine spins a generator to produce electricity.
(iv) High-pressure steam is produced.
Select the correct sequence:
(A) (i), (ii), (iv), (iii)
(B) (ii), (iv), (i), (iii)
(C) (ii), (i), (iv), (iii)
(D) (iii), (i), (ii), (iv)

101. What physical characteristic is central to the classification of fossil fuels into coal, petroleum, and natural gas?
(A) State of matter at ambient temperature and pressure
(B) Specific color profile
(C) Geologic age
(D) Depth of discovery

102. What is Coal Bed Methane (CBM)?
(A) Methane that is adsorbed onto the solid matrix of coal.
(B) A synthetic gas produced from wood.
(C) A liquid byproduct of petroleum refining.
(D) Gas found in underground caves not associated with coal.

103. Which statement about the calorific value of fuels is correct?

(A) Gross-calorific value is always lower than the net-calorific value.
(B) The difference between GCV and NCV is due to the energy contained in the ash.
(C) GCV assumes that the water vapor from combustion is fully condensed to recover its latent heat.
(D) NCV is only relevant for gaseous fuels.

104. The principle of hydropower generation involves the conversion of:
(A) Chemical energy to electrical energy via combustion.
(B) Nuclear energy to mechanical energy via fission.
(C) Potential energy to kinetic energy to electrical energy.
(D) Thermal energy to potential energy via heating.

105. In the context of energy sources, OTEC stands for:
(A) Ocean Tidal Energy Capture
(B) Offshore Thermal Energy Company
(C) Ocean Thermal Energy Conversion
(D) Oceanic Temperature Exchange Channel

106. Consider the following statements about principles of energy generation:
(a) Wind power harnesses the kinetic energy of moving air.
(b) Geothermal energy utilizes heat from the earth's interior.
(c) Solar photovoltaic modules convert light directly into electricity.
(d) Tidal energy is a form of solar energy.
(e) OTEC uses the salinity gradient of ocean water.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (a), (b), and (d)
(C) (a), (c), and (e)
(D) (b), (d), and (e)

107. Which process releases more energy per unit mass of fuel: nuclear fission or nuclear fusion?
(A) Nuclear fusion
(B) Nuclear fission
(C) Both release exactly the same amount of energy.
(D) Neither process releases energy; both consume it.

108. The main component of biogas, produced by anaerobic digestion of biomass, is:
(A) Methane
(B) Hydrogen
(C) Oxygen
(D) Carbon Monoxide

109. Which of the following is a primary cause of positive radiative forcing, leading to global warming?
(A) An increase in atmospheric aerosols that reflect sunlight.
(B) An increase in the concentration of greenhouse gases like CO2
(C) A large-scale volcanic eruption releasing sulfate particles.
(D) A decrease in the sun's total energy output.

110. The large-scale exploitation of which energy source is most directly linked to issues of habitat fragmentation and disruption of riverine ecology?
(A) Solar
(B) Wind
(C) Hydro
(D) Geothermal

111. The spectral characteristic of solar radiation is significant because:
(A) It determines the direction from which sunlight arrives.
(B) It is the sole factor determining the season.
(C) It proves that the sun is a star.
(D) Different materials and processes (like photosynthesis or PV cells) respond differently to various wavelengths.

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112. Identify the incorrect statement regarding fossil fuels.
(A) Coal is a sedimentary rock formed from ancient plant matter.
(B) Fossil fuels are considered a renewable energy source.
(C) Petroleum is a complex mixture of hydrocarbons.
(D) Natural gas is primarily composed of methane.

135. Which of the following is a primary fuel for nuclear fusion?
(A) Uranium-$_2$35
(B) Plutonium-$_2$39
(C) Thorium-$_2$3$_2$
(D) Deuterium

136. Which statement best describes the current global energy use pattern?
(A) A rapid transition has led to renewables being the dominant source of energy worldwide.
(B) Fossil fuels continue to dominate the global energy mix despite the growth of renewables.
(C) Nuclear energy provides more than half of the world's electricity.
(D) Developing countries have completely phased out the use of fossil fuels.

137. The emission of CO_2 is a major concern for which energy sources?
(A) Solar and wind
(B) Coal, petroleum, and natural gas
(C) Nuclear and geothermal
(D) Hydro and tidal

138. Consider the following statements regarding the large-scale exploitation of nuclear energy:
(a) High initial capital cost of power plants.
(b) Public perception and safety concerns.
(c) The issue of long-term radioactive waste disposal.
(d) The emission of greenhouse gases during operation.
(e) Scarcity of water for cooling purposes.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (a), (b), and (d)
(C) (c), (d), and (e)
(D) (b), (c), and (e)

139. A major environmental impact associated with the surface mining of coal is:
(A) Creation of urban heat islands.
(B) Large-scale land disturbance and habitat destruction.
(C) Improvement of soil quality.
(D) Reduction in atmospheric carbon dioxide.

140. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : India's CO_2 emissions are rising.
Reason (R) : India's growing economy, industrialization, and efforts to provide electricity to its entire population are leading to an increased demand for energy, a significant portion of which is met by fossil fuels.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

141. The energy content of coal is primarily dependent on its:
(A) Color and texture
(B) Carbon content and volatile matter
(C) Depth of the mine
(D) Age since discovery

142. The principle of geothermal energy extraction is based on:
(A) Using the Earth's magnetic field.
(B) Harnessing heat from the Earth's interior.
(C) Capturing energy from earthquakes.
(D) Utilizing the pressure of overlying rock formations.

143. Which of the following is NOT a type of biomass?
(A) Agricultural waste
(B) Wood chips
(C) Natural gas
(D) Municipal solid waste

144. The main challenge in harnessing energy from nuclear fusion is:
(A) The fuel is extremely rare and expensive.
(B) Containing the extremely high-temperature plasma required for the reaction.
(C) The process does not release a significant amount of energy.
(D) It produces more radioactive waste than fission.

145. What is the primary role of a turbine in most thermal and kinetic power plants (e.g., hydro, wind, coal, nuclear)?
(A) To create fuel for the plant.

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(B) The mass of living or recently living biological organisms.
(C) The mass of non-combustible material in coal.
(D) The weight of a nuclear reactor core.

125. The environmental impact of a large hydro project includes all of the following EXCEPT:
(A) Submergence of forests and agricultural land.
(B) Displacement of people.
(C) Increased emissions of sulfur dioxide.
(D) Alteration of downstream river flow.

126. Match List I with List II regarding energy terms and their descriptions.
List I: (Term)
P. Shale oil
Q. Coal Bed Methane
R. Gas Hydrates
S. Petroleum
List II: (Description)
1. Methane trapped in ice-like crystals
2. Natural gas extracted from coal seams
3. Liquid mixture of hydrocarbons
4. Oil obtained from heating kerogen in rock
Choose the correct option:
(A) P-1, Q-3, R-2, S-4
(B) P-4, Q-2, R-1, S-3
(C) P-4, Q-1, R-3, S-2
(D) P-3, Q-2, R-4, S-1

127. The generation of wind power is directly proportional to the:
(A) Cube of the wind speed.
(B) Square of the wind speed.
(C) Wind speed.
(D) Square root of the wind speed.

128. What is the primary environmental advantage of using nuclear power for electricity generation compared to coal?
(A) It produces cheaper electricity.
(B) The fuel is easier to transport.
(C) The operational risks are lower.
(D) It does not produce CO_2 during operation.

129. The concept of 'radiative forcing' is central to understanding:
(A) The economics of energy markets.
(B) The causes of climate change.
(C) The mechanics of nuclear fission.
(D) The principles of hydropower.

130. Arrange the following energy sources from lowest to highest energy density by mass (energy per kg):
(i) Coal
(ii) Wood (Biomass)
(iii) Natural Gas (Methane)
(iv) Uranium (in fission)
Select the correct sequence:
(A) (ii), (i), (iii), (iv)
(B) (iv), (iii), (i), (ii)
(C) (i), (ii), (iii), (iv)
(D) (ii), (iii), (i), (iv)

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131. The sun's radiation spectrum that reaches the Earth's surface is modified by the atmosphere primarily through:
(A) Magnification and intensification
(B) Absorption and scattering
(C) Chemical conversion
(D) Gravitational lensing

132. What is the main component of shale that contains the precursor to shale oil?
(A) Methane
(B) Kerogen
(C) Bitumen
(D) Anthracite

133. A key difference between a solar collector and a photovoltaic module is that:
(A) The collector produces heat, while the module produces electricity.
(B) The collector produces electricity, while the module produces heat.
(C) Both produce electricity, but using different materials.
(D) The collector works at night, while the module works only during the day.

134. Tidal energy taps into the _____ energy of water that moves due to the gravitational forces exerted by the moon and sun.
(A) Chemical
(B) Thermal
(C) Kinetic and Potential
(D) Nuclear

(b) Thorium can be used as a fertile material to breed fissile U-233.
(c) The moderator in a reactor slows down neutrons to increase the efficiency of fission.
(d) Nuclear power generation is completely free from any environmental impact.

Which of the above statements are correct?
(A) (a) and (d)
(B) (b) and (c)
(C) (a) and (c)
(D) (b) and (d)

157. Which process is NOT a method to produce bioenergy?
(A) Anaerobic digestion
(B) Fermentation to produce ethanol
(C) Direct combustion
(D) Fractional distillation of crude oil

158. The term 'radiative forcing' is used by climatologists to mean:
(A) The force of wind on a turbine blade.
(B) The change in net energy balance at the top of the atmosphere.
(C) The pressure at the bottom of the ocean.
(D) The binding energy of an atomic nucleus.

159. The energy use pattern in India is characterized by a significant dependence on:
(A) Geothermal energy
(B) Coal
(C) OTEC
(D) Gas hydrates

160. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:

Assertion (A) : The large-scale exploitation of any energy source, including renewables, has some environmental implications.

Reason (R) : Building large solar farms requires significant land, hydro dams alter river ecosystems, and manufacturing wind turbines requires energy and resources.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

161. The visible portion of the solar radiation spectrum is what the human eye perceives as:
(A) Heat
(B) Light
(C) Sound
(D) Pressure

162. Petroleum is classified as a fossil fuel because it was formed from:
(A) The remains of ancient marine microorganisms.
(B) The crystallization of minerals in the Earth's mantle.
(C) Volcanic eruptions in the prehistoric era.
(D) The compression of atmospheric gases.

163. The process of heating oil shale to produce oil and gas is called:
(A) Photosynthesis
(B) Pyrolysis
(C) Hydrolysis
(D) Electrolysis

164. What is the fundamental principle of a photovoltaic module?
(A) The Seebeck effect
(B) The Peltier effect
(C) The Photovoltaic effect
(D) The Hall effect

165. The operation of a nuclear reactor involves a chain reaction. What does this mean?
(A) The reactor components are linked together in a physical chain.
(B) The fission of one nucleus releases neutrons that cause the fission of other nuclei.
(C) The chemical reactions happen one after another in a long sequence.
(D) The fuel rods are chained to the control rods for safety.

166. A major advantage of bioenergy is that it can be:
(A) Carbon neutral, if the biomass is sourced sustainably.
(B) Generated without any land use.
(C) Completely non-polluting in all its forms.
(D) A source of infinite, free energy.

167. Which of the following is considered a significant environmental impact of large-scale hydropower projects?

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(B) To convert the kinetic or thermal energy of a moving fluid into rotational mechanical energy.
(C) To store electricity for later use.
(D) To cool down the system.

146. Which of these is a significant disadvantage of run-of-the-river hydropower compared to large-dam hydropower?
(A) It cannot provide a consistent power supply and is dependent on river flow.
(B) It has a much larger environmental footprint.
(C) It produces significant greenhouse gas emissions.
(D) It requires nuclear fuel to operate.

147. Identify the correct statement about energy sources.
(A) Solar energy is a form of chemical energy.
(B) Geothermal energy originates from the Earth's core.
(C) Wind energy is a form of potential energy.
(D) Tidal energy is caused by wind.

148. What is a solar collector?
(A) A device that collects data about the sun.
(B) A device designed to capture solar radiation and convert it into thermal energy.
(C) Another name for a photovoltaic cell.
(D) A satellite that orbits the sun.

149. Match List I with List II regarding energy concepts and terms.
List I: (Energy Concept)
P. Coal energy content
Q. Solar conversion to electricity
R. Nuclear reaction control
S. Biomass conversion to gas
List II: (Associated Term)
1. Control Rod
2. Gasification
3. Calorific Value
4. Photovoltaic effect
Choose the correct option:
(A) P-3, Q-4, R-1, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

150. A major concern with the large-scale deployment of solar photovoltaic farms is:
(A) The intermittency of the power source (day/night, clouds).
(B) The release of carbon dioxide during generation.
(C) The consumption of large volumes of water for cooling.
(D) The high risk of nuclear meltdown.

151. The sun provides energy to the Earth primarily in the form of:
(A) Cosmic rays
(B) Sound waves
(C) Electromagnetic radiation
(D) Neutrino beams

152. Which of the following is a key component of crude petroleum?
(A) Methane
(B) A complex mixture of hydrocarbons
(C) Water
(D) Solid carbon

153. A major challenge in the exploitation of gas hydrates as an energy source is:
(A) Their low energy content per unit volume.
(B) The technological difficulty and potential environmental risks of extraction.
(C) Their existence only in easily accessible, shallow waters.
(D) The fact that they are not combustible.

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154. The difference between GCV and NCV for a fuel is largest for fuels with a high content of:
(A) Carbon
(B) Sulfur
(C) Ash
(D) Hydrogen

155. Which of the following energy sources relies on a temperature gradient?
(A) Wind power
(B) Tidal power
(C) Ocean Thermal Energy Conversion (OTEC)
(D) Hydropower

156. Consider the following statements about nuclear energy:
(a) Nuclear reactors for power generation are based on the principle of nuclear fusion.

113. A key physico-chemical characteristic of petroleum that is crucial for its transportation through pipelines is its:
(A) Color
(B) Viscosity
(C) Calorific value
(D) Ash content

114. Gas hydrates are ice-like structures where gas molecules are trapped in cages of:
(A) Water molecules
(B) Salt molecules
(C) Silicate molecules
(D) Carbon molecules

115. A solar pond works on the principle of maintaining a:
(A) Temperature gradient
(B) Pressure gradient
(C) Salinity gradient
(D) Viscosity gradient

116. Which of the following correctly describes a nuclear fuel?
(A) Any material that can be burned to produce heat.
(B) A material that can sustain a nuclear fission or fusion reaction.
(C) A fossil fuel found deep within the Earth's crust.
(D) A fluid used to cool a nuclear reactor.

117. Which of the following is a method to produce energy from biomass?
(A) Pyrolysis
(B) Photolysis
(C) Hydrolysis of water
(D) Ozonolysis

118. The global energy use pattern shows that the largest share of energy is still derived from:
(A) Nuclear power
(B) Renewable sources like solar and wind
(C) Fossil fuels
(D) Hydropower

119. A potential environmental issue with the large-scale exploitation of wind power is:
(A) Greenhouse gas emissions during operation
(B) Noise and visual impact
(C) Water contamination
(D) Radioactive waste

120. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : The sun's energy is the original source for most forms of energy on Earth, including fossil fuels.
Reason (R) : Fossil fuels were formed from ancient biomass, which derived its energy from the sun through photosynthesis.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

121. The highest energy part of the solar spectrum is:
(A) Infrared
(B) Visible light
(C) Ultraviolet
(D) Radio waves

122. Consider the following statements about CO_2 emissions:
(a) Developed countries have historically been the largest contributors to cumulative CO_2 emissions.
(b) Per capita CO_2 emissions in India are currently higher than in the USA.
(c) The energy sector, particularly the burning of fossil fuels, is a major source of global CO_2 emissions.
(d) China is currently the world's largest annual emitter of CO2.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (b), (c), and (d)
(C) (a), (c), and (d)
(D) (a), (b), and (d)

123. The principle of a nuclear reactor is based on controlling:
(A) A chemical reaction
(B) A nuclear fusion reaction
(C) A nuclear fission chain reaction
(D) A geothermal heat flow

124. What is 'biomass'?
(A) The total mass of fossil fuels in a reserve.

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(A) Release of methane from decomposing submerged vegetation in the reservoir.
(B) High levels of air pollution during operation.
(C) The need for disposal of radioactive materials.
(D) The generation of loud, continuous noise.

168. Which country is currently the world's largest consumer of energy and the largest annual emitter of CO_2?
(A) India
(B) United States
(C) Russia
(D) China

169. What is a major drawback of wind power?
(A) It produces a lot of CO_2 during operation.
(B) Its availability is intermittent and not constant.
(C) The fuel is very expensive.
(D) It requires deep-sea drilling.

170. Arrange the following fossil fuels in increasing order of their typical hydrogen-to-carbon ratio:
(i) Coal
(ii) Petroleum (Oil)
(iii) Natural Gas (Methane)
Select the correct sequence:
(A) (i), (ii), (iii)
(B) (iii), (ii), (i)
(C) (ii), (i), (iii)
(D) (i), (iii), (ii)

171. The ultimate source of geothermal energy is:
(A) The sun
(B) The decay of radioactive elements and residual heat within the Earth's core.
(C) The gravitational pull of the moon.
(D) The kinetic energy of the Earth's rotation.

172. Consider the following statements about nuclear fuels:
(a) U-235 is a fissile isotope, meaning it can sustain a chain reaction.
(b) Natural uranium is composed almost entirely of U-235.
(c) U-238 can absorb a neutron to eventually become fissile PU-239.
(d) Nuclear fuels do not release any radiation.
(e) Thorium-232 is a fissile fuel.
Which of the above statements are correct?
(A) (a) and (c)
(B) (b) and (d)
(C) (a), (c), and (e)
(D) (b), (c), and (d)

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173. What is the primary purpose of a solar pond?
(A) To collect and store solar thermal energy at low cost.
(B) To generate electricity using photovoltaic cells.
(C) To provide a habitat for marine life.
(D) To desalinate sea water using sunlight.

174. Which of these is a key difference between developed and developing countries regarding CO_2 emissions?
(A) Developed countries generally have higher per capita emissions.
(B) Developed countries do not emit any CO_2
(C) Developing countries have a much higher historical responsibility for climate change.
(D) Developing countries rely exclusively on renewable energy.

175. The impact of large-scale solar exploitation includes all of the following EXCEPT:
(A) Requirement of large land area.
(B) Use of water for cleaning panels.
(C) Life-cycle emissions from manufacturing.
(D) Significant risk of large-scale explosions.

176. Match List I with List II regarding energy sources and conversion processes.
List I: (Energy Source)
P. Coal Power Plant
Q. Solar PV Cell
R. Wind Turbine
S. Nuclear Reactor
List II: (Primary Conversion Process)
1. Kinetic to Electrical
2. Photovoltaic Effect
3. Combustion
4. Nuclear Fission
Choose the correct option:
(A) P-3, Q-2, R-1, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-3, R-4, S-1

177. Arrange the following types of coal from lowest to highest rank:

(i) Peat
(ii) Lignite
(iii) Bituminous
(iv) Anthracite
Select the correct sequence:
(A) (i), (ii), (iii), (iv)
(B) (iv), (iii), (ii), (i)
(C) (ii), (i), (iv), (iii)
(D) (i), (iii), (ii), (iv)

178. OTEC is a technology that is geographically limited to:
(A) Polar regions
(B) Tropical and subtropical regions with warm surface waters
(C) Temperate coastal areas with strong winds
(D) Desert regions with high solar insolation

179. A chain reaction in a nuclear reactor is controlled by:
(A) Using moderators
(B) Using coolants
(C) Using control rods to absorb neutrons
(D) Increasing the fuel temperature

180. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : Bioenergy can be considered carbon neutral.
Reason (R) : The carbon dioxide released during the combustion of biomass is approximately equal to the carbon dioxide absorbed by the plants during their growth, creating a closed loop.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

181. The term solar radiation refers to the energy emitted by the sun in the form of:
(A) Heat only
(B) Light only
(C) Electromagnetic waves
(D) Charged particles

182. Which fossil fuel is considered the cleanest burning, in terms of producing the least CO_2 per unit of energy?
(A) Coal
(B) Petroleum
(C) Natural Gas
(D) Peat

183. Identify the incorrect pair regarding energy generation principles.
(A) Hydro-power - Gravitational potential energy
(B) Wind power - Kinetic energy of wind
(C) Geothermal energy - Earth's internal heat
(D) Solar collector - Photoelectric effect

184. The process of fusion requires:
(A) Heavy nuclei and low temperatures.
(B) Light nuclei and extremely high temperatures.
(C) A moderator and control rods.
(D) A large-dam and a turbine.

185. A major reason for the difference in energy use patterns between India and a developed Western country is:
(A) Differences in population size only.
(B) Differences in climate only.
(C) Differences in levels of industrialization, infrastructure, and per capita income.
(D) India's complete reliance on solar energy.

186. The primary environmental concern associated with the use of coal as a fuel is:
(A) The emission of CO2, SOx, NOx, and particulate matter.
(B) The risk of nuclear contamination.
(C) The alteration of ocean currents.
(D) The depletion of the ozone layer.

187. Which of the following is a potential impact of large-scale wind energy development?
(A) Changes to local microclimates.
(B) Depletion of underground water resources.
(C) Acidification of oceans.
(D) Production of radioactive waste.

188. Consider the following statements about renewable and non-renewable energy sources:
(a) Fossil fuels are non-renewable because they are consumed much faster than they are

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formed.
(b) Solar energy is considered renewable because the sun's energy is practically inexhaustines on human timescales.
(c) Nuclear energy is considered renewable because uranium is found everywhere.
(d) Biomass is a renewable energy source.
Which of the above statements are correct?
(A) (a), (b), and (d)
(B) (a) and (c) only
(C) (b), (c), and (d)
(D) (a), (b), (c) and (d)

189. The energy content of natural gas is typically measured in:
(A) Barrels
(B) Joules per cubic meter or BTUs per cubic foot
(C) Kilograms per liter
(D) Watts per square meter

190. In a nuclear power plant, what is the role of the steam generator (in a PWR) or the boiling water (in a BWR)?
(A) To moderate the neutrons.
(B) To absorb excess radiation.
(C) To transfer heat from the reactor to the turbine.
(D) To provide fuel for the reaction.

191. The increase in global average temperatures due to enhanced radiative forcing is commonly known as:
(A) Global dimming
(B) Global warming
(C) Acid deposition
(D) Ozone hole

192. Which of the following is the most significant challenge for the widespread adoption of solar and wind power?
(A) Their high greenhouse gas emissions
(B) The scarcity of sunlight and wind
(C) Their intermittency and the need for energy storage
(D) The production of nuclear waste

193. Match List I with List II regarding fuels and their characteristics.
List I: (Fuel)
P. Coal
Q. Natural Gas
R. Petroleum
S. Shale Oil
List II: (Primary Form/Characteristic)
1. Predominantly Methane (CH4)
2. Liquid hydrocarbon mixture
3. Solid carbonaceous material
4. Derived from Kerogen
Choose the correct option:
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-2, R-1, S-4
(D) P-4, Q-1, R-2, S-3

194. The composition of natural gas is predominantly:
(A) Carbon dioxide
(B) Methane
(C) Hydrogen
(D) Oxygen

195. The term Gross-calorific value refers to the total heat released when a fuel is burned and:
(A) The water vapor produced is not condensed.
(B) The water vapor produced is condensed back to liquid water.
(C) Only the carbon content is burned.
(D) The ash content is also combusted.

196. The principle of OTEC relies on operating a heat engine using:
(A) The pressure difference between the surface and deep ocean.
(B) The temperature difference between warm surface and cold deep ocean water.
(C) The velocity of ocean currents.
(D) The salinity difference between ocean and river water.

197. Which of these is a fissile material, commonly used as a fuel in nuclear reactors?
(A) Uranium-$_2$38
(B) Uranium-$_2$35
(C) Deuterium
(D) Carbon-1$_2$

198. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : The Net Calorific Value (NCV) of a fuel is a more realistic measure of the usable heat in many practical applications like boilers

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gas.
(B) Pumping out water to reduce pressure in the coal seam.
(C) Injecting steam to liquefy the coal and release methane.
(D) Using hydraulic fracturing to create pathways for gas flow.

268. According to the passage, gas hydrates are crystalline solids where methane is trapped within a lattice of:
(A) water molecules.
(B) carbon molecules.
(C) silicate minerals.
(D) sulfur compounds.

269. A key distinction made in the passage is between shale oil (from kerogen) and:
(A) crude oil from conventional wells.
(B) natural gas liquids.
(C) 'tight oil' extracted via hydraulic fracturing.
(D) coal-derived liquid fuels.

270. The passage identifies which of the following as a major environmental risk associated with the extraction of gas hydrates?
(A) Increased water salinity in coastal areas.
(B) Acid rain from sulfur dioxide release.
(C) Depletion of the stratospheric ozone layer.
(D) Potential for methane release and seabed instability.

Direction : Please read the following source carefully.

The energy content inherent in a fuel is precisely quantified by its calorific value, defined as the total heat released during the fuel's complete combustion. Within this concept, a crucial distinction is made between the Gross Calorific Value (GCV) and the Net Calorific Value (NCV). The Gross Calorific Value, which is also termed the higher heating value, signifies the total quantity of heat liberated when a unit mass of the fuel undergoes complete combustion and the resulting products are cooled down to the pre-combustion temperature. This GCV measurement comprehensively includes the latent heat of vaporization of any water produced during the combustion process. This water originates from both the hydrogen content of the fuel and any pre-existing moisture within it. However, in most practical combustion systems, such as engines and boilers, the water vapor in the exhaust gases is not condensed and is expelled as steam, meaning its latent heat is not recovered. The Net Calorific Value, or lower heating value, is calculated to reflect this reality by subtracting the latent heat of vaporization of the water vapor from the GCV. Consequently, the NCV represents the actual usable heat energy available in the majority of real-world applications. The discrepancy between GCV and NCV is particularly pronounced for fuels rich in hydrogen, like natural gas, as they generate a larger quantity of water upon combustion.

Based on the above source, attempt the following five questions.

271. What is the fundamental difference between Gross Calorific Value (GCV) and Net Calorific Value (NCV)?
(A) GCV is measured in joules, while NCV is measured in calories.
(B) GCV applies only to solid fuels, whereas NCV applies only to gaseous fuels.
(C) GCV accounts for the latent heat of vaporization of water, while NCV does not.
(D) GCV represents incomplete combustion, while NCV represents complete combustion.

272. According to the passage, the Net Calorific Value represents:
(A) the total potential energy stored within the fuel's chemical bonds.
(B) the usable heat energy available in most practical combustion systems.
(C) the theoretical maximum heat output in a laboratory setting.
(D) the heat absorbed by the fuel during the combustion process.

273. The difference between GCV and NCV would be greatest for which of the following fuels?
(A) A fuel with a high carbon content and low hydrogen content.
(B) A fuel with a high ash content.
(C) A fuel with no hydrogen or moisture content.
(D) A fuel with a high hydrogen content.

274. The passage states that the water produced during combustion, which affects the calorific value, originates from:

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(D) Animal power.

209. What is a primary environmental concern related to the life cycle of photovoltaic panels?
(A) The use of hazardous materials in their manufacturing and disposal challenges.
(B) The emission of CO_2 during electricity generation.
(C) The high water consumption during operation.
(D) The noise produced by the panels.

210. Which one of the following statements is incorrect?
(A) The Sun is the ultimate source of energy for wind and hydropower.
(B) Coal is a fossil fuel.
(C) Natural gas is a major cause of ozone layer depletion.
(D) Nuclear fission is the splitting of a heavy nucleus.

211. In a Pressurized Water Reactor (PWR), one of the most common types of nuclear reactors, what is the function of the high pressure?
(A) To increase the speed of the fission reaction.
(B) To keep the water in the primary loop from boiling.
(C) To compress the nuclear fuel into a smaller volume.
(D) To reduce the amount of radiation escaping the core.

212. Identify the correct statement regarding CO_2 emissions.
(A) The concentration of CO_2 in the atmosphere has been increasing since the industrial revolution.
(B) All countries in the world have the same per capita CO_2 emissions.
(C) Developing countries are historically responsible for the majority of CO_2 in the atmosphere.
(D) Burning hydrogen fuel produces significant CO_2 emissions.

213. A significant impact of large-scale hydro projects is the potential for:
(A) Increased acid rain in the immediate vicinity.
(B) Induced seismicity due to the weight of the water in the reservoir.
(C) Enhancement of fish populations upstream.
(D) A decrease in local humidity.

214. Consider the following events in the formation of coal:
(i) Burial and compaction under sediment.
(ii) Plant matter accumulates in a swamp environment.
(iii) Heat and pressure cause chemical and physical changes.
(iv) Formation of peat.
Select the correct chronological order:
(A) (ii), (iv), (i), (iii)
(B) (iv), (ii), (iii), (i)
(C) (ii), (i), (iv), (iii)
(D) (i), (ii), (iii), (iv)

215. What is the primary difference in composition between natural gas and petroleum?
(A) Natural gas is primarily methane, while petroleum is a mix of longer-chain hydrocarbons.
(B) Natural gas is a solid substance, while petroleum is a gas found in subterranean pockets.
(C) Natural gas is non-combustible, while petroleum is highly combustible in liquid form.
(D) There is no significant difference in the chemical composition between these two fuels.

216. Which of the following is NOT a direct consequence of the combustion of fossil fuels?
(A) Release of carbon dioxide.
(B) Production of radioactive waste.
(C) Release of sulfur and nitrogen oxides.
(D) Generation of heat energy.

217. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : Wind turbines are more efficient at higher altitudes.
Reason (R) : Wind speeds are generally higher and less turbulent at greater heights above the ground.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct

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explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

218. The energy from the sun is generated by the fusion of hydrogen nuclei into:
(A) Oxygen nuclei
(B) Carbon nuclei
(C) Helium nuclei
(D) Iron nuclei

219. The calorific value of a fuel is a measure of its:
(A) Temperature
(B) Energy content
(C) Density
(D) Purity

220. Consider the following statements about energy technologies:
(a) A solar collector captures thermal energy.
(b) A photo-voltaic module converts light into current.
(c) A solar pond uses a salinity gradient to trap heat.
(d) A tidal barrage uses the potential energy of tides.
(e) OTEC uses the kinetic energy of waves.
Which of the above statements are correct?
(A) (a), (b), (c), (d)
(B) (a), (c), (d), (e)
(C) (a), (b), (d), (e)
(D) (b), (c), (d), (e)

221. Match List I with List II regarding energy terms and sources.
List I: (Term)
P. Kerogen
Q. Fission
R. Turbine Blade
S. Anaerobic Digestion
List II: (Associated Energy Source)
1. Nuclear Energy
2. Wind Power
3. Bioenergy
4. Shale Oil
Choose the correct option:
(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-2, R-1, S-3
(D) P-3, Q-1, R-2, S-4

222. The primary role of a moderator in a thermal nuclear reactor is to:
(A) Increase the speed of neutrons.
(B) Absorb neutrons to stop the reaction.
(C) Slow down fast neutrons to thermal energies.
(D) Heat the coolant.

223. Radiative forcing is a concept that quantifies the change in energy fluxes caused by:
(A) The earth's rotation.
(B) Natural and anthropogenic drivers of climate change.
(C) The moon's gravitational pull.
(D) The ocean conveyor belt.

224. The energy use pattern in a highly industrialized country differs from a less industrialized one mainly in:
(A) The per capita energy consumption.
(B) The total amount of energy consumed.
(C) The type of energy used (e.g., more industrial and transport fuels).
(D) All of the above.

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225. A key negative impact of the large-scale use of dams for hydroelectricity is:
(A) High CO_2 emissions during operation.
(B) Disruption to aquatic and terrestrial ecosystems.
(C) Production of nuclear waste.
(D) High operational fuel costs.

226. Which of the following is NOT a fossil fuel?
(A) Coal
(B) Petroleum
(C) Natural Gas
(D) Biomass

227. The term 'physico-chemical characteristics' of coal would include properties such as:
(A) Hardness, density, moisture content, and chemical composition.
(B) The price per ton and market demand.
(C) The name of the mine and its location.
(D) The type of machinery used to extract it.

228. Which factor is crucial for the principle of wind power generation?
(A) The kinetic energy of the moving air.
(B) The temperature of the air.

(C) The humidity of the air.
(D) The electrical conductivity of the air.

229. A significant difference between a Boiling Water Reactor (BWR) and a Pressurized Water Reactor (PWR) is that:
(A) Only a PWR uses uranium as fuel.
(B) In a BWR, steam is generated directly inside the reactor vessel.
(C) A BWR does not require a coolant.
(D) A PWR operates at a lower pressure than a BWR.

230. Which of the following represents a significant environmental implication of using fossil fuels?
(A) Enhancement of stratospheric ozone.
(B) An increase in atmospheric greenhouse gas concentrations.
(C) A decrease in sea level.
(D) A cooling effect on the global climate.

231. The exploitation of solar energy on a large scale requires consideration of:
(A) Its intermittent nature and land requirements.
(B) The high level of radiation it releases into the environment.
(C) The constant noise it produces.
(D) Its contribution to acid rain.

232. Consider the following statements about fossil fuels:
(a) They are formed over millions of years from organic matter.
(b) Their combustion releases energy.
(c) Coal, petroleum, and natural gas are the three main types.
(d) Their global reserves are infinite.
Which of the above statements are correct?
(A) (a), (b), and (c)
(B) (a), (b), and (d)
(C) (a), (c), and (d)
(D) (b), (c), and (d)

233. The 'calorific value' of a fuel is the quantity of:
(A) Heat produced by the complete combustion of a unit quantity of the fuel.
(B) Light produced when the fuel is burned.
(C) Unburnt carbon left after combustion.
(D) Water vapor produced during combustion.

234. In Ocean Thermal Energy Conversion (OTEC), the temperature difference is used to:
(A) Drive a turbine directly with seawater.
(B) Boil a working fluid with a low boiling point, which then drives a turbine.
(C) Create a high-pressure jet of water.
(D) Heat salt to a molten state.

235. The fundamental principle of a nuclear reactor is to control the rate of:
(A) Chemical reactions.
(B) Nuclear fusion.
(C) Nuclear fission.
(D) Radioactive decay.

236. The following question consists of two statements, Assertion (A) and Reason (R). Choose the correct option:
Assertion (A) : Gas hydrates, particularly methane hydrates, represent a vast potential source of natural gas.
Reason (R) : They are difficult to extract safely and there is a risk of releasing large amounts of methane, a potent greenhouse gas, into the atmosphere.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

237. Which of the following is a method for producing energy from biomass?
(A) Fractional distillation
(B) Catalytic cracking
(C) Gasification
(D) Nuclear Fission

238. A country's energy use pattern is most strongly correlated with its:
(A) Level of economic development and industrialization.
(B) National flag design.
(C) Average annual rainfall.
(D) Predominant religion.

239. Compared to developed nations, the per capita CO_2 emissions in India are:
(A) Significantly lower
(B) Considerably higher

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and engines.

Reason (R) : In many practical systems, the exhaust gases are released at a temperature high enough that the water vapor produced during combustion does not condense, and its latent heat of vaporization is not recovered.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

199. What is the primary environmental benefit of using bioenergy over fossil fuels?
(A) It has a higher energy density.
(B) It can be potentially carbon-neutral.
(C) It requires no land for production.
(D) It produces no emissions when burned.

200. The impacts of large-scale exploitation of solar energy include:
(A) Land use for solar farms, and life-cycle impacts of manufacturing panels.
(B) Continuous emission of greenhouse gases during operation.
(C) Risk of radiation leaks.
(D) Disruption of fish migration patterns.

201. The spectrum of solar radiation includes ultraviolet, visible, and infrared bands. Which band contains the most energy when considering the total solar irradiance?
(A) Ultraviolet
(B) Visible
(C) Infrared
(D) All have equal energy

202. Which of the following is a key physico-chemical characteristic of coal used for its grading?
(A) Its color intensity
(B) Its crystalline structure
(C) Its calorific value and ash content
(D) Its magnetic susceptibility

203. A major technical hurdle for the commercial exploitation of gas hydrates is:
(A) The deposits are too deep to be reached by current technology.
(B) The risk of uncontrolled methane release during extraction.
(C) The gas is not flammable and therefore not a useful fuel.
(D) The ice-like structures are too hard to break.

204. Consider the following statements about various energy generation principles:
(a) A solar collector uses a fluid to transfer thermal energy.
(b) A photo-voltaic module generates a voltage when exposed to light.
(c) Geothermal energy is a manifestation of solar energy.
(d) Wind power is a form of solar energy, as winds are driven by solar heating of the atmosphere.
(e) Tidal energy is derived from the Earth's internal heat.

Which of the above statements are correct?
(A) (a), (b), (c)
(B) (c), (d), (e)
(C) (a), (b), and (d)
(D) (a), (c), (e)

205. The process of combining light atomic nuclei, such as hydrogen, to form a heavier nucleus is called:
(A) Nuclear Fission
(B) Nuclear Fusion
(C) Radioactive Decay
(D) Combustion

206. A common method to produce bio-energy from wet biomass like animal manure or sewage is:
(A) Direct combustion
(B) Gasification
(C) Anaerobic digestion
(D) Pyrolysis

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207. A positive radiative forcing indicates that the Earth's system is:
(A) Gaining energy, leading to warming.
(B) Losing energy, leading to cooling.
(C) In a stable energy balance.
(D) Increasing its reflectivity (albedo).

208. The energy use pattern in the world is currently shifting, with a notable increase in the share of:
(A) Coal and oil.
(B) Nuclear energy.
(C) Renewable energy sources like solar and wind.

(D) The mix of energy sources used.

Direction : Please read the following source carefully.

The Sun serves as the fundamental source of energy for Earth, emitting this energy as electromagnetic radiation across a broad spectrum. This solar radiation is indispensable for life and the primary driver of the planet's climatic and weather systems. The spectral characteristics of this radiation are of critical scientific importance, as it is not monochromatic but composed of a range of wavelengths. This spectrum is typically divided into ultraviolet (UV), visible light, and infrared (IR) radiation. A substantial portion of the Sun's energy output is concentrated within the visible spectrum, the range of wavelengths that facilitates photosynthesis in plants. The energy distribution across the spectrum is not uniform, with the peak intensity of solar radiation occurring within the visible light portion. As this radiation passes through Earth's atmosphere, it is significantly modified. The atmosphere absorbs and scatters certain wavelengths; for instance, the stratospheric ozone layer effectively absorbs a large fraction of the incoming UV radiation, while gases like water vapor and carbon dioxide absorb energy in the infrared range. A thorough understanding of these spectral characteristics is vital for the design and optimization of various solar energy technologies, as different devices are engineered to efficiently capture specific portions of the solar spectrum.

Based on the above source, attempt the following five questions.

251. Which of the following statements best describes the spectral characteristics of solar radiation as presented in the passage?
(A) Solar radiation is primarily monochromatic, consisting only of visible light.
(B) Solar radiation is composed of UV, visible, and IR wavelengths, with peak intensity in the visible spectrum.
(C) Solar radiation has a uniform energy distribution across all wavelengths.
(D) Solar radiation consists mainly of infrared energy, with minor contributions from UV and visible light.

252. According to the passage, what is the primary role of the Earth's atmosphere in relation to incoming solar radiation?
(A) To modify the radiation by absorbing and scattering specific wavelengths.
(B) To amplify the intensity of all wavelengths of solar radiation.
(C) To convert all incoming radiation into visible light.
(D) To reflect all incoming solar radiation back into space.

253. The passage implies that understanding the spectral characteristics of solar radiation is crucial for which of the following?
(A) Predicting the exact timing of solar flares.
(B) Determining the chemical composition of the Sun's core.
(C) Developing more effective solar energy capture devices.
(D) Measuring the distance between the Earth and the Sun.

254. Based on the source, which atmospheric component is primarily responsible for absorbing a significant portion of ultraviolet radiation?
(A) Water vapor
(B) Carbon dioxide
(C) Particulate matter
(D) The ozone layer

255. The passage highlights that the concentration of solar energy in the visible spectrum is particularly significant because it:
(A) is responsible for the Earth's magnetic field.
(B) is the primary cause of atmospheric scattering.
(C) drives the process of photosynthesis.
(D) is the main source of infrared absorption.

Direction : Please read the following source carefully.

Coal stands as a principal fossil fuel, originating from the compression and heating of terrestrial plant remains over vast geological epochs. Its formal classification is determined by the degree of metamorphism it has undergone, a concept known as 'rank'. This rank is directly correlated with its essential properties, including carbon content, moisture levels, and overall energy value.

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The primary ranks of coal, in ascending order of carbon concentration and energy content, are lignite, sub-bituminous, bituminous, and anthracite. Lignite, representing the lowest rank, is characterized by its high moisture content and consequently lower energy output. In contrast, bituminous coal is extensively utilized for electricity generation and in the metallurgical industry for steel production, owing to its high energy content and relative abundance. Anthracite, which holds the highest rank, is distinguished by its hardness, superior carbon content, and its capacity to burn with a very clean flame. However, its occurrence is less common compared to other ranks. The elemental composition of coal consists mainly of carbon, hydrogen, oxygen, nitrogen, and sulfur. Key physico-chemical characteristics such as hardness, density, and calorific value are defined by its rank. The energy content, a pivotal attribute, progressively increases with the rank. The presence of impurities like sulfur and ash critically influences its environmental impact and combustion efficiency, rendering coal's composition a decisive factor in energy and environmental planning.

Based on the above source, attempt the following five questions.

256. According to the passage, what is the primary basis for the classification of coal?
(A) The geographical location of its discovery.
(B) The degree of metamorphism or rank.
(C) The depth at which it is mined.
(D) Its color and physical texture.

257. Which of the following correctly lists the ranks of coal in increasing order of energy content?
(A) Anthracite, Bituminous, Sub-bituminous, Lignite
(B) Bituminous, Anthracite, Lignite, Sub-bituminous
(C) Sub-bituminous, Lignite, Anthracite, Bituminous
(D) Lignite, Sub-bituminous, Bituminous, Anthracite

258. The passage suggests that the environmental impact of burning coal is significantly influenced by:
(A) the presence of impurities such as sulfur and ash.
(B) the amount of carbon and hydrogen in its composition.
(C) its hardness and density.
(D) the geological era of its formation.

259. Based on the information provided, why is bituminous coal widely used for generating electricity?
(A) It has the highest carbon content of all coal ranks.
(B) It is abundant and has a high energy content.
(C) It is abundant and has a high energy content.
(D) It has a very high moisture content which aids combustion.

260. What is the relationship between coal rank and its characteristics as described in the source?
(A) As rank increases, moisture content decreases and energy content increases.
(B) As rank increases, moisture content increases and carbon content decreases.
(C) As rank increases, both moisture and energy content decrease.
(D) As rank increases, both carbon content and moisture content increase.

Direction : Please read the following source carefully.

Petroleum, commonly known as crude oil, and natural gas are fossil fuels composed of hydrocarbons, formed primarily from the anaerobic decomposition of marine microorganisms subjected to intense heat and pressure over millions of years. Petroleum is not a single compound but a complex mixture of various hydrocarbons, including alkanes, cycloalkanes, and aromatic hydrocarbons. These components are separated in refineries through fractional distillation to yield a range of commercially valuable products such as gasoline, diesel fuel, and kerosene. The physico-chemical characteristics of crude oil, notably its viscosity and density (often expressed as API gravity), exhibit significant variation among different sources worldwide. Natural gas consists predominantly of methane (CH4), along with smaller quantities of lighter hydrocarbons like ethane, propane, and butane. It is often regarded as a cleaner-burning fossil fuel relative to coal and petroleum, as its combustion results in the emission of fewer pollutants and a lower volume of carbon dioxide per unit of energy

released. The energy content of both petroleum derivatives and natural gas is exceptionally high, solidifying their crucial role in the global energy supply. They are typically extracted from subterranean reservoirs, where they are frequently found in association, and their exploration and production constitute major global industries. The specific composition of these fuels is a direct determinant of their energy yield and associated environmental footprint.

Based on the above source, attempt the following five questions.

261. According to the passage, petroleum and natural gas were predominantly formed from:
(A) the remains of terrestrial vegetation.
(B) volcanic and magmatic processes.
(C) the compression of atmospheric gases.
(D) the decomposition of marine microorganisms.

262. The process used to separate crude oil into products like gasoline and diesel is identified as:
(A) catalytic cracking.
(B) fractional distillation.
(C) polymerization.
(D) pyrolysis.

263. Why is natural gas considered a cleaner-burning fossil fuel compared to petroleum?
(A) It has a higher energy content per unit mass.
(B) It is easier to extract from underground reservoirs.
(C) It produces fewer pollutants and less CO_2 upon combustion.
(D) It is primarily composed of complex aromatic hydrocarbons.

264. Which property is mentioned as a key physico-chemical characteristic used to differentiate types of crude oil?
(A) Its color and odor.
(B) Its electrical conductivity.
(C) Its solubility in water.
(D) Its viscosity and density.

265. What is the primary constituent of natural gas as described in the source?
(A) Methane
(B) Ethane
(C) Propane
(D) Butane

Direction : Please read the following source carefully.

In addition to conventional energy reserves, the focus of energy exploration is increasingly turning towards unconventional fossil fuels, which necessitate the use of advanced and often complex extraction technologies. Shale oil is a prominent unconventional resource, which consists of solid organic matter, specifically kerogen, embedded within shale rock formations. This kerogen is converted into a synthetic form of crude oil through a process known as pyrolysis, which involves heating the shale rock to high temperatures. This method is distinct from the hydraulic fracturing techniques used to extract 'tight oil' from shale. Another significant resource is Coal Bed Methane (CBM), which is natural gas, composed mainly of methane, that is adsorbed onto the internal surfaces of coal seams. The extraction of CBM typically involves drilling into the coal seam and dewatering it by pumping out groundwater. This reduction in hydrostatic pressure facilitates the desorption of methane from the coal matrix, allowing it to be collected. Gas hydrates, also referred to as clathrates, represent another vast potential resource. These are crystalline, ice-like structures in which gas molecules, predominantly methane, are trapped within a lattice of water molecules. They are primarily found in the sediments of deep oceans and in permafrost regions. While the energy potential of gas hydrates is immense, their extraction remains a significant technological challenge and carries environmental risks, including the potential for large-scale methane release and compromised seabed stability.

Based on the above source, attempt the following five questions.

266. What is the solid organic matter found in shale rock that is converted into shale oil?
(A) Methane
(B) Kerogen
(C) Bitumen
(D) Anthracite

267. The extraction of Coal Bed Methane primarily involves which of the following steps?
(A) Heating the coal seam to release adsorbed

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(C) Approximately same
(D) Marginally higher

240. The large-scale exploitation of which energy source poses a risk of radioactive contamination?
(A) Solar
(B) Wind
(C) Hydro
(D) Nuclear

241. What part of the solar spectrum is largely absorbed by the ozone layer in the stratosphere?
(A) Infrared-A radiation
(B) Visible light spectrum
(C) Ultraviolet-C (UVC)
(D) Microwave frequencies

242. Rank the following fossil fuels from lowest to highest energy content per unit mass (specific energy).
(A) Coal < Petroleum < Natural Gas
(B) Natural Gas < Petroleum < Coal
(C) Petroleum < Coal < Natural Gas
(D) All have the same energy content

243. The net-calorific value is lower than the gross-calorific value because it does not account for the latent heat of:
(A) Fusion of ash
(B) Vaporization of water
(C) Sublimation of carbon
(D) The fuel itself

244. The principle of tidal power generation involves using the rise and fall of ocean water to:
(A) Turn turbines.
(B) Heat a working fluid.
(C) Create a high-temperature plasma.
(D) Initiate a chemical reaction.

245. Match List I with List II regarding energy types and principles.
List I: (Energy Type)
P. Solar Photovoltaic
Q. Geothermal
R. Hydropower
S. OTEC
List II: (Basic Principle)
1. Earth's internal heat
2. Conversion of photons to electrons
3. Ocean temperature difference
4. Gravitational potential energy of water
Choose the correct option:
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-3, R-1, S-4
(D) P-4, Q-1, R-2, S-3

246. Consider the following statements about nuclear fission and fusion:
(a) Fission is the splitting of a heavy nucleus.
(b) Fusion is the combining of light nuclei.
(c) Current nuclear power plants operate on the principle of fusion.
(d) Fusion releases more energy per nucleon than fission.
(e) Fission produces radioactive waste products.
Which of the above statements are correct?
(A) (a), (b), (c), (d)
(B) (a), (b), (d), (e)
(C) (a), (c), (d), (e)
(D) (b), (c), (d), (e)

247. The direct conversion of solar energy into electricity is achieved by:
(A) Photovoltaic modules
(B) Solar collectors
(C) Solar ponds
(D) Solar water heaters

248. The most significant driver of the increase in atmospheric CO_2 concentrations since the 19th century is:
(A) Volcanic activity
(B) The burning of fossil fuels
(C) Deforestation
(D) Changes in the Earth's orbit

249. A major environmental impact associated with the large-scale exploitation of wind energy is:
(A) Visual and aesthetic impact on the landscape.
(B) Acid rain formation and deposition.
(C) Water pollution from the turbines.
(D) Soil contamination during operation.

250. The difference in energy use patterns between developed and developing countries is reflected in:
(A) All of the above.
(B) The per capita energy consumption.
(C) The total energy consumption.

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(A) both the fuel's hydrogen content and its inherent moisture.
(B) only the moisture already present in the fuel.
(C) only the hydrogen content of the fuel.
(D) the oxygen in the air combining with carbon.

275. Why is the GCV also referred to as the higher heating value?
(A) Because it is only relevant for high-temperature applications.
(B) Because it is more difficult to calculate than the NCV.
(C) Because it includes the heat energy contained in the water vapor, making it a larger value than NCV.
(D) Because it applies only to fuels with a high rank or grade.

Direction : Please read the following source carefully.

Multiple renewable energy technologies effectively harness the immense power of water in its various forms. Hydropower generation operates on the fundamental principle of converting the gravitational potential energy of water, stored in a reservoir at a significant height, into kinetic energy. This is achieved by allowing the water to flow downwards, driving turbines that are connected to electrical generators. This process typically necessitates the construction of a dam to create the reservoir and establish the necessary head difference. Tidal energy technologies exploit the predictable, periodic rise and fall of ocean sea levels, which are driven by the gravitational pull of the moon and the sun. The two principal methods for harnessing this energy are tidal barrages and tidal stream generators. A tidal barrage functions similarly to a hydropower dam built across an estuary, capturing potential energy at high tide and releasing it at low tide. In contrast, tidal stream generators are analogous to underwater wind turbines, designed to capture the kinetic energy of the moving currents. Ocean Thermal Energy Conversion (OTEC) is a more technologically intensive marine energy solution that capitalizes on the temperature differential between warm surface seawater and cold deep ocean water. In a typical closed-cycle OTEC plant, a working fluid with a low boiling point, like ammonia, is vaporized by the warm surface water to power a turbine. The vapor is subsequently condensed back to a liquid state using the cold water pumped from oceanic depths, allowing the cycle to repeat continuously. OTEC is primarily viable in tropical regions where a substantial and stable temperature gradient is available throughout the year.

Based on the above source, attempt the following five questions.

276. Which energy conversion principle is fundamental to hydropower generation?
(A) Converting potential energy to kinetic energy to electrical energy.
(B) Converting chemical energy to electrical energy.
(C) Converting thermal energy to mechanical energy.
(D) Converting nuclear energy to electrical energy.

277. A key difference between a tidal barrage and a tidal stream generator is that:
(A) a barrage uses temperature differences, while a stream generator uses water flow.
(B) a barrage is used in rivers, while a stream generator is used in oceans.
(C) a barrage is a new technology, while a stream generator is an old one.
(D) a barrage captures potential energy, while a stream generator captures kinetic energy.

278. The operation of an Ocean Thermal Energy Conversion (OTEC) system is dependent on which of the following conditions?
(A) Strong and consistent ocean currents.
(B) A substantial temperature difference between surface and deep ocean water.
(C) A significant height difference created by a dam.
(D) The periodic rise and fall of tides.

279. What is the role of the working fluid (e.g., ammonia) in a closed-cycle OTEC system?
(A) To cool the deep ocean water before it is discharged.
(B) To absorb sunlight directly and heat the surface water.
(C) To be vaporized to drive a turbine and then condensed to repeat the cycle.
(D) To lubricate the moving parts of the

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generator.

280. The passage compares tidal stream generators to which of the following?
(A) Hydropower dams
(B) Solar panels
(C) Geothermal vents
(D) Underwater wind turbines

Direction : Please read the following source carefully.

Wind power and geothermal energy represent two distinct yet significant sources of renewable energy, each based on unique generation principles. The fundamental principle of wind power generation lies in the conversion of the kinetic energy of moving air into mechanical energy, which is subsequently transformed into electricity. This is accomplished using wind turbines that feature large rotor blades. These blades capture the wind's kinetic energy, causing the rotor to spin. This rotation is transferred through a shaft to a gearbox, which serves to increase the rotational speed to a frequency suitable for an electric generator. The power output from a wind turbine is critically dependent on several factors, including the wind speed, the density of the air, and the total swept area of the turbine's blades. In contrast, geothermal energy generation is based on harnessing the thermal energy originating from the Earth's interior. This immense heat, produced by the planet's molten core and the radioactive decay of elements in the crust, is transferred to underground reservoirs of water or steam. In a geothermal power plant, deep wells are drilled to access these geothermal reservoirs and bring the hot fluid to the surface. The resulting steam is then directed to drive a turbine connected to an electric generator. Geothermal plants are categorized based on the resource type, leading to dry steam, flash steam, or binary cycle systems. Flash steam plants, which are the most prevalent, utilize high-pressure hot water that flashes into steam as its pressure is abruptly reduced at the surface.

Based on the above source, attempt the following five questions.

281. What is the primary energy conversion that takes place in a wind turbine?
(A) Kinetic energy to mechanical energy.
(B) Thermal energy to electrical energy.
(C) Potential energy to kinetic energy.
(D) Chemical energy to mechanical energy.

282. According to the passage, the power output of a wind turbine is dependent on all of the following EXCEPT:
(A) wind speed.
(B) the geothermal gradient.
(C) air density.
(D) the swept area of the blades.

283. The source of energy for geothermal power is described as:
(A) solar radiation absorbed by the ground.
(B) heat from the Earth's interior and radioactive decay.
(C) friction from tectonic plate movement.
(D) chemical reactions in underground water reservoirs.

284. What is the operating principle of a flash steam geothermal plant?
(A) It brings high-pressure hot water to the surface, where a pressure drop causes it to turn to steam.
(B) It uses naturally occurring surface steam directly from a geyser.
(C) It burns natural gas to superheat water into steam.
(D) It uses a secondary fluid with a low boiling point to create vapor.

285. How does the principle of wind power generation differ from that of geothermal energy generation?
(A) Wind power is intermittent, while geothermal is entirely predictable.
(B) Wind power requires a turbine, while geothermal does not.
(C) Wind power uses a kinetic source, while geothermal uses a thermal source.
(D) Wind power generates DC electricity, while geothermal generates AC electricity.

Direction : Please read the following source carefully.

The utilization of solar energy is accomplished through a variety of distinct technologies designed for different energy conversion pathways. Solar collectors are specifically engineered for solar thermal applications, where their primary

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function is to convert sunlight directly into heat. These devices are broadly categorized as non-concentrating, such as the common flat-plate collectors used for domestic water heating, and concentrating collectors. The latter type employs mirrors or lenses to focus sunlight from a large area onto a much smaller receiver, thereby achieving the high temperatures required for industrial process heat or electricity generation. In stark contrast, photovoltaic (PV) modules achieve the direct conversion of sunlight into electricity via the photovoltaic effect. A PV module consists of an assembly of multiple solar cells, which are typically fabricated from semiconductor materials like silicon. When photons from sunlight strike these cells, they excite electrons, generating a direct current (DC). This DC electricity can then be used to power devices directly, be stored in batteries for later use, or be converted into alternating current (AC) by an inverter for integration with standard electrical grids. A less widespread but highly innovative approach is the solar pond. This technology involves a large-scale body of saline water that is engineered with a salinity gradient, where the salt concentration increases with depth. This gradient suppresses natural convection, allowing the bottom layer of the pond to trap solar energy and become significantly hotter than the surface. The thermal energy stored in this bottom layer can subsequently be extracted for power generation or heating purposes, making the solar pond a combined energy collection and storage system.

Based on the above source, attempt the following five questions.

286. What is the primary functional difference between a solar collector and a photovoltaic module?
(A) A collector works only with direct sunlight, while a PV module works with diffuse light.
(B) A collector uses silicon, while a PV module uses mirrors.
(C) A collector stores energy, while a PV module does not.
(D) A collector generates heat, while a PV module generates electricity.

287. The passage describes concentrating solar collectors as devices that:
(A) use flat plates to absorb heat for water heating.
(B) directly convert photons into a direct current.
(C) use mirrors or lenses to focus sunlight to achieve high temperatures.
(D) store thermal energy in a body of saline water.

288. The electricity initially generated by a photovoltaic cell is in what form?
(A) Alternating Current (AC)
(B) Direct Current (DC)
(C) High-frequency pulsed current
(D) Low-voltage thermal current

289. How does a solar pond prevent heat from escaping its bottom layer?
(A) By using a glass cover to trap infrared radiation.
(B) By continuously circulating the water with a pump.
(C) By painting the bottom of the pond black.
(D) By a salinity gradient that suppresses convection.

290. Based on the passage, which technology serves as both a solar energy collection and storage system?
(A) A solar pond
(B) A flat-plate collector
(C) A photovoltaic module
(D) A concentrating solar collector

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Direction : Please read the following source carefully.

Nuclear energy is a powerful energy source derived from processes occurring within the nucleus of an atom. The predominant method employed for commercial electricity generation is nuclear fission. This process involves the splitting of a heavy atomic nucleus, typically Uranium-235 or Plutonium-239, into two or more smaller nuclei. This act of fission releases a tremendous amount of energy, along with additional neutrons. These released neutrons can subsequently induce fission in other nearby nuclei, creating the potential for a self-sustaining chain reaction. Nuclear fuels, most commonly enriched uranium, are manufactured into fuel rods and arranged within the core of a nuclear reactor. The fundamental operating principle of a nuclear reactor is to

precisely control this chain reaction to generate heat at a constant, manageable rate. This thermal energy is then used to boil water, creating high-pressure steam that drives a turbine connected to an electric generator. Common designs for such reactors include Pressurized Water Reactors (PWRs) and Boiling Water Reactors (BWRs), both of which utilize ordinary water as a coolant to transfer heat and as a moderator to slow down neutrons. An alternative, and potentially more powerful, source of nuclear energy is nuclear fusion. This is the process of combining two light atomic nuclei, such as the hydrogen isotopes deuterium and tritium, to form a heavier nucleus. This fusion reaction releases even more energy per unit mass than fission. While fusion is the process that powers the sun, achieving controlled and sustained fusion reactions on Earth for practical power generation remains a formidable scientific and engineering challenge.

Based on the above source, attempt the following five questions.

291. What is the fundamental process of nuclear fission as described in the passage?
(A) The combining of two light atomic nuclei into a heavier one.
(B) The radioactive decay of an atom without external influence.
(C) The splitting of a heavy atomic nucleus into lighter ones.
(D) The conversion of thermal energy directly into nuclear energy.

292. In a nuclear reactor, what is the primary purpose of controlling the chain reaction?
(A) To produce heat at a steady and manageable rate.
(B) To maximize the number of neutrons released.
(C) To directly generate an electrical current from the fuel rods.
(D) To create new, heavier elements through fusion.

293. The passage identifies Pressurized Water Reactors (PWRs) and Boiling Water Reactors (BWRs) as types that use water for which two functions?
(A) As a fuel and a shield.
(B) As a lubricant and a turbine fluid.
(C) As a reactant and a catalyst.
(D) As a coolant and a moderator.

294. How does nuclear fusion differ from nuclear fission?
(A) Fusion releases less energy than fission.
(B) Fusion involves combining light nuclei, while fission involves splitting heavy nuclei.
(C) Fusion involves splitting nuclei, while fission involves combining them.
(D) Fusion is used in all commercial reactors, while fission is still experimental.

295. According to the source, a significant challenge associated with nuclear fusion is:
(A) the scarcity of light nuclei like deuterium and tritium.
(B) the excessive radioactive waste it produces compared to fission.
(C) achieving a controlled and sustained reaction for power generation.
(D) the low amount of energy it releases.

Direction : Please read a following source carefully.

The environmental implications stemming from energy use are both profound and wide-ranging. The current global energy use pattern, which is predominantly dependent on the combustion of fossil fuels, stands as a primary contributor to anthropogenic climate change. This combustion process releases vast quantities of carbon dioxide (CO2), a significant greenhouse gas, into the atmosphere. Historically, developed nations have been the largest per capita emitters of CO2; however, emissions from developing countries, including India, are now rising sharply in line with their industrialization and economic growth. This ongoing accumulation of atmospheric CO2 enhances the natural greenhouse effect, resulting in radiative forcing—a net imbalance in the Earth's energy budget—which in turn drives global warming. While renewable energy sources present a cleaner alternative to fossil fuels, their large-scale exploitation is not without its own set of environmental impacts. For instance, the construction of large hydroelectric dams can cause extensive habitat destruction, force the displacement of human communities, and fundamentally alter riverine ecosystems. Expansive wind farms may create visual and noise pollution and have been shown to negatively

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affect local bird and bat populations. The manufacturing process for solar panels is energy-intensive and involves the use of hazardous materials. Furthermore, nuclear energy, despite its low CO2 emission profile, carries the risks of catastrophic accidents, generates long-lived radioactive waste requiring secure disposal, and contributes to thermal pollution of water bodies. Thus, a sustainable energy strategy must carefully weigh energy needs against the diverse environmental consequences of each available source.

Based on the above source, attempt the following five questions.

296. According to the passage, the primary environmental consequence of the global reliance on fossil fuels is:
(A) depletion of the ozone layer.
(B) acid rain and water pollution.
(C) soil erosion and desertification.
(D) the release of CO_2 leading to global warming.

297. The term radiative forcing as used in the source refers to:
(A) an imbalance in the Earth's energy budget caused by greenhouse gases.
(B) the force exerted by solar winds on the magnetosphere.
(C) the radioactive decay of elements in the Earth's crust.
(D) the gravitational pull affecting tidal energy.

298. Which of the following is mentioned as a potential negative environmental impact of large-scale hydroelectric projects?
(A) Increased CO_2 emissions.
(B) Habitat destruction and altered river ecosystems.
(C) Generation of radioactive waste.
(D) Release of hazardous manufacturing chemicals.

299. The passage suggests that a challenge associated with the large-scale exploitation of wind energy is its impact on:
(A) marine ecosystems.
(B) local bird and bat populations.
(C) river flow and sediment transport.
(D) groundwater levels.

300. What is the central argument presented in the passage regarding energy sources?
(A) All energy sources, including renewables, have associated environmental impacts that must be considered.
(B) Only fossil fuels have significant environmental impacts.
(C) Renewable energy sources are entirely free of environmental consequences.
(D) Nuclear energy is the only viable long-term solution for climate change.

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ANSWERS

1. (B) The Sun
The Sun serves as the primary driver for nearly all natural phenomena occurring on the planet surface. It provides the necessary thermal energy that governs atmospheric circulation patterns and the global hydrological cycle. Through the process of photosynthesis, solar radiation is converted into chemical energy, forming the basis of food chains and sustaining biological life. Additionally, fossil fuels represent ancient solar energy stored within organic matter over millions of years.
This celestial body remains the most fundamental energy provider, influencing weather, climate, and every ecosystem across the globe consistently.

2. (A) Ultraviolet, Visible, Infrared
Solar radiation spans a broad electromagnetic spectrum, but most energy reaching the Earth's atmosphere is concentrated in three specific regions. Ultraviolet radiation has short wavelengths and high energy, while visible light constitutes the portion detectable by the human eye. Infrared radiation consists of longer wavelengths and is primarily responsible for the heating effect of sunlight. These bands collectively influence the Earth's energy balance and various biological and physical processes.
Each spectral band interacts differently with atmospheric gases and the surface, determining how much energy is absorbed or reflected.

3. (C) Solar radiation is subject to absorption and scattering as it passes through the atmosphere.
Solar radiation entering the Earth's atmosphere does not reach the surface at its full initial intensity. Various atmospheric constituents, including gases like ozone, water vapor, and aerosols, absorb specific wavelengths of the incoming energy. Simultaneously, air molecules and small particles scatter radiation in different directions, which contributes to the sky's appearance. Consequently, the quantity and quality of solar energy available for surface applications depend on atmospheric clarity.
These interactions reduce the total irradiance and alter the spectral distribution of the energy reaching the ground.

4. (A) Both A and R are true and R is the correct explanation of A.
The Sun acts as the fundamental energy provider for the complex climate system of the Earth. It provides the necessary heat to establish temperature gradients, which in turn drive planetary wind systems and ocean currents. This solar influx also powers the evaporation process within the hydrological cycle. Because the Earth receives this radiation continuously, it sustains the ecological and physical processes required for maintaining global temperatures and life.
The reasoning directly supports the claim that the sun is the central energy source for the entire climate.

5. (C) Their physical state (solid, liquid, or gas)
Fossil fuels are broadly categorized based on the physical state they naturally exhibit under standard environmental conditions. This classification distinguishes between solid fuels such as coal, liquid fuels like crude oil or petroleum, and gaseous fuels like natural gas. Each state indicates different molecular complexities and geological histories of formation. Understanding these states is essential for determining the appropriate methods for extraction, processing, transportation, and ultimate combustion.
Physical states dictate the infrastructure needed for energy production, ranging from mining operations to complex pipeline networks.

6. (B) Uranium
Fossil fuels are formed from the decomposition of buried organic matter over millions of years under specific geological conditions. Coal, petroleum, and natural gas are the primary examples of these carbon-based energy sources. In contrast, uranium is a heavy metal found in the Earth's crust and is used as a fuel for nuclear energy. While both are non-renewable, uranium energy is released through nuclear fission rather than chemical combustion.

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This distinction is critical in energy studies, as fossil fuels release carbon dioxide whereas nuclear fuel involves radioactive decay.

7. (A) P-4, Q-2, R-1, S-3
Different types of fossil fuels are defined by their unique chemical compositions and physical forms. Natural gas is primarily composed of methane, while coal exists as a solid carbonaceous material. Petroleum represents a complex liquid mixture of various hydrocarbons. Shale oil is obtained from kerogen, which is the organic precursor trapped within sedimentary rock. Each of these fuels requires specific refining processes to extract usable energy for industrial and residential applications.
Identifying these primary constituents helps in evaluating the energy density and environmental impact of each fuel type used.

8. (A) Calorific value
The energy content of a fuel, which represents the total amount of heat released during its complete combustion, is technically defined as its calorific value. This measurement is vital for comparing the efficiency and economic value of different energy sources. It is typically expressed in units of energy per unit mass or volume. High calorific values indicate that a fuel provides more heat for the same quantity consumed, maximizing power output.
This value is a fundamental parameter in thermodynamics and fuel science, used to design engines and industrial boilers.

9. (C) Natural gas is almost exclusively composed of carbon dioxide.
Natural gas is a combustible mixture primarily composed of methane, which is a potent hydrocarbon fuel. While it may contain trace amounts of other gases like carbon dioxide, nitrogen, or hydrogen sulfide, its value as an energy source comes from its high methane concentration. Claiming it consists almost entirely of carbon dioxide is incorrect because carbon dioxide is a non-combustible byproduct rather than a primary fuel component.
Understanding the chemical makeup of natural gas is essential for its processing and for ensuring safe and efficient combustion.

10. (A) (a), (b), and (c)
Gas hydrates are crystalline solids formed when gas molecules, most commonly methane, are trapped within a lattice of water molecules. These structures are stable only under conditions of high pressure and low temperature, typically found in deep oceanic sediments and arctic permafrost regions. Although they contain fossil energy, they are solid ice-like substances rather than liquid fuels. They represent a significant but technically challenging potential energy resource for the future global economy.
The stability of these hydrates is highly sensitive to environmental changes, making their extraction a complex engineering task.

11. (D) Condensation of water vapor produced during combustion
Gross calorific value accounts for the total heat released when a fuel is burned, including the latent heat of vaporization. When hydrogen-containing fuels burn, water vapor is formed as a byproduct. In a laboratory setting, if this vapor is condensed back into liquid water, its latent heat is recovered, resulting in a higher measured energy value. This differs from net calorific value, where the water remains in a gaseous state and its heat is lost.
This distinction is crucial for engineers when calculating the actual efficiency of thermal power plants and internal combustion engines.

12. (B) Converting potential energy of stored water into kinetic and then electrical energy.
Hydropower generation begins with the storage of water at an elevation, which creates gravitational potential energy. When this water is released and flows downward through pipes or penstocks, the potential energy is converted into kinetic energy. This moving water then strikes the blades of a turbine, causing it to spin and drive an electrical generator. The entire process follows the law of conservation of energy by transforming mechanical movement into electricity.
This renewable energy method utilizes the natural hydrological cycle and is one of the most established power technologies globally.

13. (C) (C) A form of natural gas extracted from coal seams.
Coal bed methane is a type of unconventional natural gas that is found within coal deposits. During the process of coalification, methane

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is generated and remains adsorbed onto the solid matrix of the coal or is trapped in the surrounding rock fractures. This gas can be extracted by drilling into the coal seams and reducing the surrounding water pressure. It provides an important clean-burning fuel source that is distinct from conventional gas reserves.
Extraction of this resource requires specialized drilling techniques and management of the water that must be pumped out first.

14. (A) Both A and R are true and R is the correct explanation of A.
The net calorific value is always lower than the gross calorific value because it excludes the latent heat of vaporization of water produced during combustion. Most fossil fuels contain hydrogen, which combines with oxygen to form water vapor. In gross calorific value measurements, this vapor is condensed, and its heat is included in the total. However, in net calorific value, the water stays as steam, meaning that part of the energy is effectively unavailable for work.
This difference is essential for practical energy calculations, as most real-world combustion systems do not recover this latent heat.

15. (A) The gravitational pull of the Moon and the Sun
Tidal power is generated by harnessing the movement of seawater caused by the gravitational forces exerted by the Moon and the Sun on the Earth. These forces create a predictable rise and fall in sea levels, known as tides. By capturing the kinetic energy of tidal currents or the potential energy from the difference in water height, electricity can be produced. This makes tidal energy a highly predictable and reliable renewable energy resource.
Unlike solar or wind energy, tidal cycles are determined by celestial mechanics and are not affected by weather conditions.

16. (B) The temperature difference between deep and shallow ocean water
Ocean Thermal Energy Conversion technology exploits the thermal gradient present in tropical oceans. The surface of the ocean is heated by the sun, while the deep water remains very cold. This temperature difference is used to drive a heat engine, often involving a working fluid that evaporates at the surface temperature and condenses at the deep-water temperature. The resulting pressure difference turns a turbine to generate electricity, providing a consistent source of renewable energy.
This process is most effective in tropical regions where the temperature gap between layers is at its maximum.

17. (B) Hydro-power can only be generated from fast-flowing rivers, not from stored water in dams.
Hydropower can be generated both from run-of-the-river systems and from large reservoirs created by dams. In fact, most large-scale hydropower plants rely on stored water to provide a consistent and controllable flow to the turbines. This storage allows the facility to manage electricity production according to demand, regardless of the immediate river flow rate. Stored water represents gravitational potential energy, which is a highly effective way to generate substantial amounts of renewable power.
The claim that hydropower is limited only to fast-flowing rivers ignores the critical role of dams in modern electricity.

18. (A) The photoelectric effect
Photovoltaic modules operate based on the photoelectric effect, where certain semiconductor materials convert light energy directly into electricity. When photons from sunlight strike the surface of a solar cell, they excite electrons, creating an electric current. This process allows for the generation of clean energy without moving parts or chemical combustion. The efficiency of this conversion depends on the properties of the materials used and the intensity of the incoming solar radiation.
This principle is the foundation of modern solar power technology, enabling silent and sustainable electricity generation for various applications.

19. (C) Absorb solar radiation and transfer it as heat to a fluid.
Solar collectors are devices designed to capture the thermal energy provided by sunlight. They typically consist of a dark surface that absorbs solar radiation and transfers the resulting heat to a working fluid, such as water or air, flowing through the system. This heated fluid can then be used directly for domestic heating, industrial processes, or to drive a mechanical system. Unlike photovoltaic cells, collectors focus on

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thermal conversion rather than direct electricity production.
These systems are widely used for water heating and are an efficient way to utilize solar energy for thermal needs.

20. (A) (i), (ii), (iv), (iii)
The rank of coal reflects the degree of metamorphism it has undergone, which directly correlates with its carbon content and energy density. Peat is the earliest stage of coal formation and has the lowest carbon concentration. Lignite, or brown coal, follows with slightly higher carbon. Bituminous coal is a denser form with significant energy content. Anthracite is the highest rank, characterized by the highest carbon percentage and the lowest amount of moisture and volatile matter.
As coal progresses through these ranks, its heating value increases while its impurities and moisture content generally decrease.

21. (C) The splitting of a heavy nucleus into two or more lighter nuclei.
Nuclear fission is a process in which the nucleus of a heavy atom, such as uranium-235, is split into two or more smaller nuclei. This reaction is usually initiated by the absorption of a neutron and releases a significant amount of energy along with additional neutrons. These neutrons can then trigger further fission events, creating a self-sustaining chain reaction. This principle is utilized in commercial nuclear power plants to generate heat and produce electricity.
The energy released in this process comes from the binding energy that holds the atomic nucleus together.

22. (B) The Sun and other stars
Nuclear fusion is the process where light atomic nuclei, such as hydrogen isotopes, combine to form a heavier nucleus like helium. This reaction occurs under extreme temperatures and pressures, releasing immense amounts of energy. It is the fundamental power source for the Sun and all other stars in the universe. While researchers are working to develop controlled fusion on Earth for power generation, it currently remains a technological challenge compared to standard nuclear fission.
Fusion is highly desirable as a future energy source because it produces minimal radioactive waste and uses abundant fuel.

23. (B) (b), (c), and (d)
Shale oil is an unconventional resource obtained from oil shale rock, which contains a solid organic material known as kerogen. Unlike conventional crude oil, which can be pumped directly from the ground, shale oil requires the rock to be heated in a process called pyrolysis to convert the kerogen into liquid hydrocarbons. This extraction method is more complex and energy-intensive than traditional drilling. It represents a vast potential energy source but presents significant environmental challenges.
Understanding the difference between shale oil and conventional oil is vital for evaluating global energy reserves and extraction technologies.

24. (A) Enriched Uranium (U-235)
Most commercial nuclear reactors utilize uranium-235 as their primary fuel source because it is a fissile isotope capable of sustaining a controlled chain reaction. Since natural uranium contains only a small percentage of this isotope, it is often processed to increase the concentration of uranium-235, a process known as enrichment. Once enriched, the material is formed into fuel pellets and placed within the reactor core. This fuel provides concentrated energy through the process of nuclear fission.
Uranium enrichment levels are carefully regulated to ensure the safe and efficient operation of civilian nuclear power facilities.

25. (C) To slow down fast neutrons to increase the probability of fission.
In a nuclear reactor, the neutrons released during fission typically move at very high speeds. However, these fast neutrons are less likely to be absorbed by uranium-235 nuclei to cause further fission. A moderator, such as water or graphite, is used to surround the fuel and slow these neutrons down to thermal speeds. By reducing their kinetic energy, the moderator significantly increases the probability of sustaining a stable and efficient nuclear chain reaction within the core.
The choice of moderator material is a key design feature that defines different types of nuclear reactor technologies.

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26. (A) Internal Combustion Reactor (ICR)
Nuclear power generation relies on specific reactor designs such as Pressurized Water Reactors, Boiling Water Reactors, and Gas Cooled Reactors. These systems use nuclear fission to generate heat, which is then used to produce steam for electricity. An Internal Combustion Reactor does not exist in the field of nuclear engineering. Internal combustion refers to engines that burn fossil fuels within a cylinder to produce mechanical work, which is a fundamentally different process from nuclear energy generation.
Distinguishing between nuclear and chemical energy systems is essential for understanding different power generation technologies and their operations.

27. (D) Organic matter, known as biomass.
Bioenergy is a form of renewable energy derived from organic materials, collectively referred to as biomass. This includes plant matter, agricultural residues, wood, and even animal waste. The energy stored in these materials originally comes from the sun through the process of photosynthesis. Bioenergy can be utilized through direct combustion for heat, or it can be processed into liquid biofuels and biogas. It provides a versatile alternative to traditional fossil fuels for various energy needs.
Utilizing biomass for energy helps in managing waste and reducing the overall carbon footprint of energy consumption systems.

28. (B) Direct combustion
Direct combustion is the most common and traditional method for extracting energy from biomass. In this process, organic materials like wood, straw, or municipal waste are burned in the presence of oxygen to release heat energy. This heat can be used directly for cooking and space heating, or it can be used to produce steam for generating electricity in power plants. While other methods exist, simple burning remains the primary way biomass contributes to global energy.
This technology is widely accessible and can be implemented at both small domestic scales and large industrial scales.

29. (C) The emission of greenhouse gases like CO_2.
The combustion of fossil fuels is the primary human activity responsible for the large-scale release of carbon dioxide and other greenhouse gases into the atmosphere. These gases trap heat within the Earth's climate system, leading to the phenomenon of global warming and associated climate change. While fossil fuels provide significant energy, their environmental impact on the global carbon cycle is the most critical challenge facing modern society. Reducing these emissions is essential for long-term environmental sustainability.
Addressing greenhouse gas emissions requires a shift toward cleaner energy sources and improved energy efficiency across all sectors.

30. (D) The difference between the incoming solar energy absorbed by the Earth and the energy radiated back to space.
Radiative forcing is a scientific concept used to measure the influence of various factors on the Earth's energy balance. It quantifies the difference between the solar radiation absorbed by the planet and the infrared energy emitted back into space. A positive forcing value indicates that the Earth is retaining more energy than it loses, which leads to a warming effect on the climate. This metric is fundamental for understanding the impact of greenhouse gases and aerosols on global temperatures.
Scientists use radiative forcing to compare the warming potential of different substances in the atmosphere over specific timeframes.

31. (A) Historically, developed countries have contributed a larger share of cumulative CO2 emissions than developing countries.
Industrialization began much earlier in developed nations, leading to a long history of intensive fossil fuel consumption. Consequently, these countries have contributed the vast majority of the cumulative carbon dioxide currently residing in the atmosphere. While emissions in developing nations are now rising due to rapid economic growth, the historical burden remains largely with established industrial economies. This historical context is a central theme in international climate negotiations regarding responsibility and financial assistance for environmental mitigation.

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Understanding cumulative emissions is crucial for evaluating the long-term impact of different regions on the global climate system.

32. (B) Habitat destruction and alteration of river ecosystems.
Large-scale hydropower projects require the construction of massive dams, which significantly alter the natural flow of rivers and flood vast areas of land. This process destroys local terrestrial habitats and disrupts the migration and breeding patterns of aquatic species. Changes in water temperature and sediment flow can also have long-term negative effects on downstream ecosystems. While hydropower is a renewable source of electricity, these ecological impacts represent a major environmental trade-off for its widespread exploitation and use.
Balancing the need for renewable energy with the protection of biodiversity is a key challenge in sustainable development planning.

33. (B) Large land area requirement, potentially impacting ecosystems and land use.
Solar farms require significant amounts of land to install the large number of panels necessary for utility-scale power generation. This can lead to the displacement of agricultural activities or the fragmentation of natural habitats, particularly in sensitive desert or grassland ecosystems. While the operation itself is clean, the physical footprint of these facilities can create conflicts with other land-use needs and local biodiversity. Careful site selection is necessary to minimize these potential negative environmental consequences of solar energy.
Efficient land management and the integration of solar panels into existing structures can help reduce the land-use impact.

34. (A) The management and disposal of radioactive waste.
Nuclear energy production generates radioactive waste that remains hazardous for thousands of years. Finding safe, permanent disposal solutions for high-level waste is a significant technical and political challenge. While nuclear power plants do not emit carbon dioxide during operation, the long-term containment of spent fuel is essential to prevent environmental contamination. This concern remains a primary focus of nuclear safety regulations and public debate regarding the role of nuclear power in the future global energy mix. Robust waste management strategies are vital for ensuring the safety and public acceptance of nuclear energy technologies worldwide.

35. (C) Its refinement into various products like gasoline and diesel.
Petroleum is a complex mixture of various hydrocarbons, and its specific physical and chemical properties determine how it can be processed. In a refinery, crude oil is separated into different fractions based on boiling points and molecular weights. Characteristics such as viscosity, density, and sulfur content are critical for producing high-quality fuels like gasoline, diesel, and jet fuel. Understanding these traits ensures that the refining process is efficient and that the final products meet industrial standards. Chemical analysis of crude oil is the first step in maximizing the value of petroleum resources for modern transportation.

36. (D) A turbine with blades
Wind power generation relies on the conversion of the kinetic energy of moving air into mechanical energy. This is achieved using a turbine equipped with large blades that are designed to capture the wind. As the wind flows over the blades, it creates lift and causes the rotor to spin. This rotation is then used to drive an internal generator that produces electricity. The turbine is the central component that determines the efficiency of the wind energy system.
Modern wind turbine designs are highly engineered to optimize energy capture across a wide range of wind speeds and conditions.

37. (D) (a), (b), (c), and (d)
All energy sources have specific environmental and social implications that must be carefully managed. Fossil fuel combustion is a primary driver of global warming due to carbon emissions, while large hydro projects often lead to the displacement of human communities. Wind energy can impact local bird populations, and while nuclear power is a low-carbon option during operation, it has its own unique waste management challenges. Recognizing these diverse impacts is essential for developing a balanced and sustainable national energy strategy.

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which can then be used in modified or specific types of engines for transportation and power.
These conversion technologies are essential for making biomass energy a versatile and practical alternative to traditional fossil-based liquid fuels.

86. (B) Coal - Solid carbonaceous rock
Coal is a fossil fuel that exists as a solid, carbon-rich rock formed from the remains of ancient plants. Petroleum is a liquid mixture of hydrocarbons, and natural gas is a gaseous mixture primarily composed of methane. Identifying the correct physical state and composition of these fuels is fundamental to understanding their formation, extraction, and use. Each fuel type requires specific industrial infrastructure and technology for its development and integration into the global energy supply chain.
Distinguishing between these fossil fuels is the first step in analyzing their energy density and environmental impact in various applications.

87. (B) Nuclear fission releases energy by converting a small amount of mass into energy, according to $E=mc^2$.
Nuclear fission is a process where the mass of the resulting fragments is slightly less than the mass of the original heavy nucleus. This lost mass is converted into energy according to Einstein's famous equation, releasing an immense amount of heat. This principle allows for the generation of large quantities of electricity from a small amount of nuclear fuel. Unlike chemical combustion, nuclear energy does not involve oxygen or the release of carbon dioxide during the fission process itself.
This fundamental physical law explains why nuclear energy is so much more concentrated than the energy stored in chemical bonds.

88. (B) Uses a dark-colored plate to absorb sunlight and heat a fluid.
A flat-plate solar collector is a common device used to capture solar thermal energy. It consists of an insulated box with a dark-colored absorber plate that absorbs solar radiation and converts it into heat. This heat is then transferred to a fluid, usually water or air, that circulates through tubes attached to the plate. These systems are highly effective for domestic water heating and other low-temperature applications, providing a simple and sustainable way to utilize solar energy.
The efficiency of these collectors is enhanced by using glazing to reduce heat loss to the surrounding environment and atmosphere.

89. (B) A large difference between high tide and low tide.
Tidal energy generation is most effective in locations where the geographic features of the coastline amplify the difference between high and low tides. A larger tidal range means there is more potential and kinetic energy available to turn turbines and generate electricity. Sites with small tidal ranges are generally not economically viable for large-scale power production. Therefore, identifying and developing these specific high-energy coastal areas is the primary focus of tidal power projects around the world today.
The predictability of tidal cycles makes this resource a valuable addition to a diversified and sustainable renewable energy portfolio globally.

90. (A) (a), (b), and (c)
Fossil fuels exhibit a wide range of characteristics based on their type and origin. Natural gas generally has a higher energy content per unit mass than coal because it is richer in hydrogen. Petroleum composition can vary significantly depending on the geological history of the reservoir it came from. Additionally, higher-rank coals like anthracite have a much higher carbon content than lower-rank coals like lignite. Recognizing these variations is essential for the efficient and responsible use of these resources.
These differences in composition and energy density determine the commercial value and environmental impact of each fossil fuel source.

91. (B) The fuel for fusion (deuterium, tritium) is more widely available and abundant than uranium.
Nuclear fusion is highly attractive as a future energy source because its primary fuel, deuterium, can be extracted from seawater, making it virtually inexhaustible. Unlike uranium, which must be mined and enriched, fusion fuels are abundant and widely distributed across the planet. Furthermore, fusion does not produce long-lived radioactive waste or carry the risk of a core meltdown. While fusion technology is still under development, its potential for provide safe, clean, and limitless energy is a major global goal.

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44. (A) Both A and R are true and R is the correct explanation of A.
Developed countries typically exhibit much higher per capita energy consumption than developing nations. This pattern is driven by advanced industrial sectors, high levels of automobile ownership, and energy-intensive lifestyles common in affluent societies. The infrastructure and technological systems in these countries require vast amounts of power to maintain. Therefore, the degree of economic development and the associated standard of living are the primary factors that explain the high energy demand observed in these established industrial nations.
Bridging the gap in energy access while promoting efficiency is a major focus of international development and climate goals.

45. (C) Hydrocarbon structure
Proximate analysis is a standard method used to characterize the basic physical composition of coal. It involves measuring the moisture content, volatile matter, ash content, and fixed carbon present in a sample. This analysis provides essential information for determining the quality and combustion characteristics of the coal. It does not, however, determine the detailed chemical hydrocarbon structure, which would require a more complex ultimate analysis. Proximate analysis is primarily used for industrial grading and commercial valuation of coal.
These parameters help engineers optimize furnace performance and manage the residues produced during the coal burning process.

46. (A) Thermal energy
A solar pond is a specialized body of water designed to capture and store solar radiation as heat. By maintaining a salinity gradient, the pond prevents the natural process of convection, allowing the bottom layers to become much hotter than the surface. This trapped energy is stored as thermal energy, which can then be used for various purposes such as industrial heating or low-temperature power generation. The system effectively acts as a large-scale solar collector and heat storage unit.
This technology offers a cost-effective way to utilize solar energy for long-term thermal applications in suitable climatic regions.

47. (A) (ii), (iv), (i), (iii)
The generation of hydropower follows a logical physical sequence. First, water is stored at an elevated level behind a dam to create potential energy. Next, this water is directed to flow through a penstock, converting the potential energy into kinetic energy. The moving water then passes through a turbine, causing its blades to turn and generate mechanical work. Finally, the spinning turbine drives a generator, which produces the electricity that is then transmitted to the power grid.
This ordered process ensures the efficient transformation of gravitational energy into a versatile and clean form of power.

48. (A) Shale oil
Kerogen is a solid, waxy organic material found within certain sedimentary rocks, most notably oil shale. It represents the precursor to petroleum that has not yet undergone the full geological process of conversion into liquid oil. To produce shale oil, the rock must be heated to high temperatures through a process called pyrolysis, which breaks down the kerogen into usable liquid and gaseous hydrocarbons. Therefore, kerogen is the essential component that defines the energy potential of oil shale.
Understanding the properties of kerogen is fundamental for developing efficient extraction technologies for unconventional oil and gas resources.

49. (C) Limited number of suitable sites with high tidal ranges.
Generating significant power from tides requires a large difference between high and low water levels, known as the tidal range. Such conditions are only found in a limited number of coastal locations worldwide where the local geography amplifies the tidal effect. This geographic restriction is a major barrier to the widespread adoption of tidal energy. While the technology is predictable and clean, it cannot be implemented as broadly as solar or wind power because of this site specificity.
Identifying and developing these prime locations is the primary focus of tidal energy projects around the world today.

50. (A) (a), (b), and (d)

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A comprehensive understanding of these factors helps policy makers make informed decisions about the future of the energy sector.

38. (B) Methane
Natural gas is a fossil fuel consisting primarily of methane, which usually makes up more than eighty percent of its volume. The energy released during the combustion of natural gas is directly related to its methane concentration, as methane is the simplest and most abundant hydrocarbon in the mixture. Other components like ethane and propane add to the energy content but are present in much smaller amounts. Consequently, methane levels are the primary indicator of natural gas quality.
Methane's high hydrogen-to-carbon ratio makes it the cleanest-burning fossil fuel, producing less carbon dioxide per unit of energy.

39. (D) Fission splits atoms; fusion combines them.
The fundamental difference between the two main types of nuclear reactions lies in the behavior of the atomic nuclei. Nuclear fission involves the splitting of a heavy, unstable nucleus into smaller, lighter parts, a process that releases energy. Conversely, nuclear fusion is the joining of two light nuclei to form a single heavier nucleus, which also releases immense energy. While fission is currently used in all commercial power plants, fusion is the process that naturally powers stars like the sun.
Both processes convert mass into energy, following Einstein's mass-energy equivalence principle, but they involve opposite physical mechanisms.

40. (A) P-3, Q-4, R-1, S-2
Each energy technology operates based on a specific physical principle or utilizes a particular natural resource. Geothermal energy harnesses the heat from within the Earth, while solar photovoltaic systems utilize the photoelectric effect to generate electricity. Ocean Thermal Energy Conversion relies on the temperature difference between ocean layers, and wind energy captures the kinetic energy of moving air masses. Understanding these underlying principles is crucial for designing and implementing diverse renewable energy systems across various geographic locations.
These different technologies provide a range of options for reducing reliance on fossil fuels and promoting environmental sustainability.

41. (C) Agricultural crop residue
Biomass energy is derived from organic materials that were recently living, making it a renewable resource. Agricultural crop residues, such as stalks, husks, and straw, are excellent examples of biomass feedstocks that can be used for energy production. Unlike fossil fuels like crude oil or natural gas, which take millions of years to form, biomass can be replenished quickly. These residues can be burned directly or processed into fuels like ethanol or biogas to provide sustainable energy.
Utilizing agricultural waste for bioenergy helps in reducing waste disposal problems while providing a local source of power.

42. (A) To regulate the rate of fission by absorbing neutrons
Control rods are essential safety and operational components in a nuclear reactor. They are made of materials like boron or cadmium that have a high capacity for absorbing neutrons. By inserting or withdrawing these rods from the reactor core, operators can precisely control the number of neutrons available to cause further fission. This allows for the regulation of the power output and ensures that the nuclear chain reaction remains stable and does not become uncontrolled.
The ability to quickly insert control rods provides a vital mechanism for shutting down the reactor in an emergency.

43. (D) It produces substantial CO2 emissions during operation.
Wind energy is a clean and renewable resource that produces virtually no carbon dioxide or other greenhouse gas emissions during its operational phase. While there are some emissions associated with the manufacturing and installation of the turbines, the generation of electricity itself is emission-free. Other concerns like land use, noise pollution, and risks to bird populations are valid environmental considerations, but the claim of substantial carbon dioxide production during operation is factually incorrect for wind power.
Wind power remains one of the most effective technologies for reducing the carbon footprint of the global electricity sector.

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Monitoring changes in radiative forcing is essential for predicting future climate trends and developing effective mitigation strategies worldwide.

56. (B) Nuclear fusion
Biomass energy can be produced using various biological and thermochemical methods such as anaerobic digestion, pyrolysis, and direct combustion. These processes utilize the energy stored in organic matter. Nuclear fusion, however, is a process involving the joining of atomic nuclei at extreme temperatures, which occurs in stars and experimental reactors. It is not a method for processing biomass. Distinguishing between biological energy sources and nuclear reactions is critical for understanding the different categories of renewable and sustainable power.
Each method of biomass energy conversion has unique advantages and is chosen based on the feedstock and desired output.

57. (A) Both A and R are true and R is the correct explanation of A.
Nuclear fusion requires enormous amounts of energy to overcome the natural electrostatic repulsion between positively charged atomic nuclei. To force these nuclei close enough for the strong nuclear force to take over and fuse them, extremely high temperatures and pressures must be maintained. At these temperatures, atoms move with immense kinetic energy, allowing for the successful collision and fusion of light elements like hydrogen. This physical requirement explains why fusion is so difficult to achieve in a controlled environment.
The immense energy released during fusion makes it a highly sought-after but technically demanding future power generation source.

58. (B) Its intensity and spectral distribution
The design and evaluation of solar energy systems depend heavily on knowing how much solar energy is available and which wavelengths it contains. Intensity determines the total power potential, while spectral distribution informs which parts of the spectrum are most effective for specific technologies, such as photovoltaic cells or solar thermal collectors. Understanding these characteristics allows engineers to optimize the performance of systems and predict their energy output under different geographic and atmospheric conditions throughout the year.
Accurate solar data is essential for the economic viability and technical success of any large-scale solar power project.

59. (C) Anthracite
Anthracite is the highest rank of coal and is characterized by a high carbon content, low moisture, and minimal volatile matter. It has undergone the most intense heat and pressure over geological time, resulting in a dense, hard mineral with the highest energy density of all coal types. Because it burns slowly with a clean, hot flame, it is highly valued for specific industrial and heating applications. It represents the final stage in the natural coalification process.
Identifying the rank of coal is vital for determining its commercial value and the most efficient way to utilize it.

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60. (B) (b), (c), and (d)
Fossil fuels like coal, petroleum, and natural gas are formed from the decomposition of organic matter under anaerobic conditions over millions of years. When burned, they release energy that was originally captured from the sun by ancient organisms. However, because they take so long to form, they are considered non-renewable on a human timescale. Once consumed, these reserves cannot be replaced within any reasonable period, making their sustainable management and the transition to renewables a global priority.
The finiteness of fossil fuel resources is a key driver for the development of alternative and renewable energy technologies.

61. (B) A salinity gradient prevents convection, trapping heat in the lower, denser layers.
A solar pond utilizes a specific concentration of salt to create a salinity gradient where the bottom of the pond is much saltier and denser than the surface. This gradient prevents the natural process of convection, where warm water would normally rise to the top and lose heat to the atmosphere. As a result, sunlight reaching the bottom of the pond heats the lower layers to very high temperatures. This trapped heat can be extracted and used for various thermal applications.

Understanding these fundamental reactor principles is essential for evaluating the safety and efficiency of different nuclear energy technologies.

74. (C) Nuclear Fusion
The immense energy produced by the Sun is the result of nuclear fusion occurring deep within its core. Under extreme temperatures and pressures, hydrogen nuclei are forced together to form helium, releasing enormous amounts of energy in the process. This energy eventually reaches the Earth as solar radiation, powering the climate and sustaining life. Fusion is the most efficient known way to release energy from matter and is the fundamental power source of the entire solar system and universe.
Scientists are currently attempting to replicate this process on Earth to provide a nearly limitless and clean source of energy.

75. (A) Calorific value
The energy content of a fuel is technically known as its calorific value, which represents the total heat released during complete combustion. This value is a fundamental property used to compare the efficiency and economic worth of different fuels. It is typically measured in a laboratory using a calorimeter and is expressed as energy per unit of mass or volume. High calorific values mean more energy is available for a given amount of fuel, making it more efficient for use.
This parameter is essential for fuel selection in industrial processes, power generation, and transportation sectors around the world.

76. (C) Improved biodiversity in mining areas.
The use of fossil fuels is associated with various negative environmental impacts, including greenhouse gas emissions, acid rain, and air pollution from particulate matter. Mining activities for coal and oil often lead to significant land disturbance and habitat loss, which typically reduces local biodiversity rather than improving it. While fossil fuels provide necessary energy, their extraction and combustion present major challenges for environmental protection. Efforts to mitigate these impacts focus on reclamation and the transition to cleaner and more sustainable energy sources.
Protecting ecosystems from the effects of energy production is a key component of modern environmental conservation and sustainable planning.

77. (A) Both A and R are true and R is the correct explanation of A.
Wind turbines have been found to impact local bird and bat populations, as these animals can collide with the fast-moving blades. This is a recognized environmental concern for large-scale wind farm developments. Proper site selection and environmental impact assessments are used to minimize these risks by avoiding major migratory paths. While wind energy is a clean resource, addressing these wildlife impacts is part of ensuring that renewable energy development is truly sustainable and environmentally responsible in the long term.
Advances in turbine design and operation are helping to reduce these risks while continuing to expand renewable energy capacity worldwide.

78. (A) Coal is a solid, petroleum is a liquid.
Coal and petroleum are both fossil fuels but exist in different physical states at standard temperature and pressure. Coal is a solid carbonaceous rock formed from ancient plant matter, while petroleum is a liquid mixture of hydrocarbons formed from marine microorganisms. These physical differences dictate how each fuel is mined or drilled, transported through pipelines or by rail, and processed for use. Understanding these states is fundamental to the study of energy resources and their industrial applications across various sectors.
Each physical state requires specific infrastructure and technology for extraction and refining into usable energy products for the global economy.

79. (B) The conversion of gravitational potential energy to kinetic energy, then to electrical energy.
A hydropower plant generates electricity by utilizing the energy of water falling from a height. The water stored in a reservoir has gravitational potential energy, which is converted into kinetic energy as it flows downward through a penstock. This moving water then spins a turbine, which is connected to a generator that converts the mechanical energy into electricity. This process is a highly efficient way to transform a natural renewable resource into a versatile and widely used form of power.

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Atmospheric conditions can shift this distribution, affecting the total energy available at the Earth's surface for different uses.

68. (B) PV module
A photovoltaic module is an energy conversion device that utilizes the photovoltaic effect to generate electricity directly from sunlight. When photons strike the semiconductor material within the cells, they release electrons, creating an electric current. This technology is distinct from solar collectors, which produce heat, or solar ponds, which store thermal energy. PV modules provide a silent and scalable way to generate clean power for everything from small electronic devices to large utility-scale solar power plants across the world.
The growth of PV technology is a major component of the global transition toward renewable and sustainable energy systems.

69. (B) Burning ice
Gas hydrates are often called burning ice because they look like white crystalline ice but contain trapped methane gas that can be ignited. They are solid structures formed at high pressures and low temperatures where water molecules create a lattice around the methane. If a piece of this substance is brought to the surface and lit, the methane burns as the ice melts. This striking physical property highlights their unique nature as a concentrated and potentially vast source of fossil energy.
Despite their energy potential, the stable extraction of gas hydrates remains a significant technical and environmental challenge for engineers.

70. (B) (i), (iv), (ii), (iii)
Different energy sources release varying amounts of carbon dioxide per unit of energy produced. Coal has the highest carbon intensity and emits the most CO2 when burned. Natural gas, while still a fossil fuel, has a higher hydrogen content and emits significantly less CO2 than coal. Renewable sources like wind and solar produce no direct CO2 emissions during their operation, making them the cleanest options. Ranking these sources helps in understanding their relative impact on global warming and climate change.
Reducing the use of high-carbon fuels is a primary strategy for lowering global greenhouse gas emissions and protecting the climate.

71. (B) The moisture present in the fuel and water formed from hydrogen combustion.
The difference between gross and net calorific values is determined by the heat required to vaporize the water associated with the combustion process. This includes both the pre-existing moisture in the fuel and the water produced when hydrogen in the fuel reacts with oxygen. In gross calorific value, this water is condensed, releasing its latent heat. In net calorific value, the water remains as vapor, and its latent heat is excluded, representing the actual heat typically available in practical applications.
This measurement is vital for determining the true efficiency of industrial boilers and various types of thermal power plants.

72. (B) (B) A significant temperature difference between surface and deep ocean water.
Ocean Thermal Energy Conversion requires a consistent temperature gradient of at least twenty degrees Celsius between the warm surface water and the cold water found deep below. This temperature difference is used to operate a heat engine that generates electricity. Without this gradient, the system cannot function efficiently. Therefore, OTEC is most suitable for tropical regions where the sun heats the surface year-round. This technology provides a continuous source of renewable energy by utilizing the ocean's thermal storage capacity.
The technical feasibility of OTEC depends on maintaining this gradient while managing the large volumes of water required for the process.

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73. (A) (a), (b), and (d)
Nuclear reactors are sophisticated devices designed to maintain a controlled fission chain reaction for power generation. Boiling Water Reactors are a specific type where steam is produced directly in the core, while most reactors use control rods made of neutron-absorbing materials like cadmium to manage the process. Contrary to some misconceptions, fusion is not yet used for commercial power, and the primary goal of these reactors is to generate heat for electricity, not to create new chemical elements.

This unique mechanism allows solar ponds to act as both energy collectors and long-term thermal storage systems.

62. (B) The exhaust gases in many systems leave at high temperatures, preventing water vapor from condensing.
In most practical combustion systems, such as boilers and internal combustion engines, the hot exhaust gases are released directly into the atmosphere. Because these gases are so hot, the water vapor formed during the burning of hydrogen does not have a chance to condense. This means the latent heat of vaporization is carried away and lost. Net calorific value accounts for this reality, making it a more accurate measure of the actual heat available for work in these devices.
Engineers use net calorific values to calculate the realistic fuel efficiency of power plants and vehicle engines in operation.

63. (C) Infrared (IR)
While the Sun emits energy across a wide spectrum, the infrared portion is primarily responsible for the thermal heating of objects and the Earth's surface. Infrared radiation has longer wavelengths than visible light and is absorbed by many materials, causing their molecules to vibrate and increase in temperature. This heating effect is essential for the Earth's climate and is the principle used in solar thermal applications. In contrast, visible light is for sight, and ultraviolet radiation has different biological effects.
Understanding the thermal properties of infrared radiation is crucial for designing buildings and solar energy systems that manage heat effectively.

64. (A) P-2, Q-4, R-1, S-3
Every component in a nuclear reactor has a distinct and essential function for safe operation. Fuel rods contain the fissile material that undergoes fission, while a moderator slows down the resulting neutrons to sustain the reaction. Control rods are used to absorb excess neutrons and regulate the power level, and a coolant transfers the generated heat away from the core to produce steam. Together, these systems ensure that the nuclear chain reaction is maintained at a controlled and productive rate.
The integration of these components is what allows a nuclear power plant to generate large amounts of reliable electricity safely.

65. (A) (A) The release of methane, a potent greenhouse gas, into the atmosphere.
Coal bed methane extraction involves removing water from coal seams to release the gas, which can lead to accidental leaks of methane into the environment. Methane is a much more powerful greenhouse gas than carbon dioxide in the short term, so even small leaks can have a significant impact on global warming. Managing these emissions is a critical environmental challenge for the industry. Ensuring the integrity of the wells and the capture system is essential for minimizing the climate impact.
Environmental regulations focus on monitoring and reducing these fugitive emissions during the extraction and transport of coal bed methane.

66. (B) Methane (CH4)
Natural gas is a fossil fuel mixture that is dominated by methane, the simplest hydrocarbon molecule. In most natural gas reserves, methane accounts for well over eighty percent of the total volume, giving the gas its primary energy characteristics. Other hydrocarbons like ethane, propane, and butane are also present but in much smaller concentrations. Because methane is the primary component, its properties and behavior define the standards for the natural gas industry and its various energy applications.
Methane's abundance and high energy content make natural gas a versatile and widely used fuel for heating and power.

67. (B) The distribution of energy across different wavelengths.
The spectral characteristics of solar radiation describe how the Sun's energy is spread out among different wavelengths, from short-wave ultraviolet to long-wave infrared. This distribution is critical because different materials and biological processes respond uniquely to specific parts of the spectrum. For example, photosynthesis relies on visible light, while solar panels are designed to capture specific bands for electricity. Knowing the spectral makeup of sunlight helps in designing more efficient energy systems and understanding its overall impact on the environment.

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Hydropower remains one of the most reliable and cost-effective methods for large-scale renewable electricity generation in many countries around the world.

80. (C) (C) The process of creating bioenergy requires nuclear fission.
Bioenergy is derived from organic matter such as plants and waste, which store energy originally captured from the sun through photosynthesis. This energy is released through biological processes or combustion, not nuclear fission. Fission is a completely different process involving the splitting of atomic nuclei. While bioenergy is renewable and carbon-neutral if managed properly, it relies on chemical and biological reactions rather than nuclear ones. Correctly identifying these principles is essential for understanding the diverse range of sustainable energy technologies.
Bioenergy plays a vital role in providing renewable fuel for heating, transportation, and electricity generation in many regions globally.

81. (A) The emission of dissolved gases like hydrogen sulfide (H_2S).
Geothermal energy extraction can release gases that are naturally dissolved in the hot underground water and steam. Hydrogen sulfide is one of the most common gases released, and it has a distinctive odor and can be harmful in high concentrations. While geothermal power is much cleaner than fossil fuels, managing these emissions is a necessary part of ensuring the environmental safety of the plant. Modern geothermal facilities use various capture and treatment systems to minimize the release of these gases.
Environmental monitoring is essential for all geothermal projects to protect local air quality and the surrounding natural environment effectively.

82. (B) Global warming
The increasing concentration of carbon dioxide in the atmosphere enhances the natural greenhouse effect, trapping more of the Earth's outgoing infrared radiation. This leads to a long-term increase in global average temperatures, a phenomenon known as global warming. This warming is the primary driver of broader climate change, affecting weather patterns, sea levels, and ecosystems. Reducing greenhouse gas emissions is the most critical challenge for stabilizing the climate and protecting the environment for future generations on a global scale.
Global efforts to combat warming focus on improving energy efficiency and transitioning to low-carbon and renewable energy sources worldwide.

83. (A) India has a higher total energy consumption but lower per capita consumption.
India has a very large population, which leads to a high total energy demand to power its growing economy and infrastructure. However, when this total consumption is divided by the number of people, the per capita energy use is much lower than that of highly developed nations like the USA. This reflects differences in industrialization levels and lifestyle standards. As India continues to develop, its energy needs are expected to grow, presenting both a challenge and an opportunity for sustainable growth.
Promoting energy access while maintaining low per capita emissions is a key goal for India's national energy and development policies.

84. (C) Remove heat from the reactor core to generate steam and prevent overheating.
The coolant in a nuclear reactor is a fluid that circulates through the core to absorb the immense heat generated by the fission reaction. This heat is then used to produce steam, which drives a turbine to generate electricity. Without a functioning coolant system, the reactor core would quickly overheat, leading to potential damage or safety issues. The coolant is therefore a vital component that ensures the steady and safe production of power from nuclear energy sources.
Different reactor designs use various coolants, such as water, gas, or liquid metal, depending on their specific technical requirements.

85. (C) Pumping it directly into a gasoline engine
Biomass must be processed or converted into a suitable fuel before it can be used in an internal combustion engine. Raw biomass cannot be pumped directly into a gasoline engine because it is solid and contains impurities that would damage the system. However, biomass can be converted into liquid biofuels like ethanol or biodiesel, or gaseous fuels like syngas or biogas,

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Current global carbon dioxide emission patterns are complex. While developing nations as a group now produce more annual emissions due to rapid growth, developed countries still maintain much higher per capita emission levels. Furthermore, the historical responsibility for the current atmospheric concentration of carbon dioxide lies largely with developed nations that industrialized earlier. India's per capita emissions remain significantly lower than those of the United States. Recognizing these differences is vital for fair and effective international climate policy and agreements.

These data points highlight the importance of balancing economic development with global environmental responsibility and climate justice.

51. (B) Its physical properties like density and boiling point, and its chemical properties like reactivity and composition.

The term physico-chemical characteristics encompasses both the physical state and the chemical makeup of a substance. For fossil fuels, this includes physical attributes such as density, viscosity, and boiling point, which affect how they are handled and transported. It also includes chemical properties like elemental composition, reactivity, and calorific value, which determine how the fuel will burn and how much energy it will release. These combined characteristics are essential for the industrial processing and efficient use of all energy resources.

Analyzing these properties allows engineers to design systems that maximize energy output while minimizing harmful environmental emissions.

52. (C) Steam or hot water from underground reservoirs

Geothermal power plants utilize the heat naturally present in the Earth's crust to generate electricity. This is usually achieved by tapping into underground reservoirs of hot water or steam. In most systems, the steam is used directly to spin a turbine, while in others, hot water is used to heat a secondary fluid that then drives the turbine. The water is often reinjected into the ground to sustain the reservoir, making geothermal energy a reliable and continuous source of renewable power.

This technology provides a constant base load of electricity that is independent of daily weather or seasonal climate variations.

53. (C) Wind turbine - Chemical energy

Energy conversion devices are defined by the type of energy they transform into a more usable form. A wind turbine converts the kinetic energy of moving air into mechanical and then electrical energy, not chemical energy. In contrast, solar collectors produce thermal energy, photovoltaic modules generate electricity, and hydropower dams utilize potential energy. Identifying the correct energy type for each technology is fundamental to understanding how different renewable resources are harnessed to meet modern power needs efficiently and sustainably.

Correctly categorizing these energy transformations is essential for the study of thermodynamics and sustainable engineering practices globally.

54. (A) Gasification

Gasification is a thermochemical process that converts solid biomass or coal into a gaseous fuel called syngas. By heating the material in a controlled environment with limited oxygen or steam, the complex organic molecules are broken down into a mixture of hydrogen and carbon monoxide. This gas can then be burned more cleanly than the original solid material or used as a chemical feedstock. Gasification provides a versatile way to utilize biomass for electricity generation and industrial applications.

This technology enhances the efficiency of biomass energy and offers a pathway for cleaner coal utilization in the future.

55. (C) Radiative forcing

Global warming is driven by an increase in the Earth's average temperature caused by an enhanced greenhouse effect. This process is scientifically described through the concept of radiative forcing, which measures the imbalance between incoming solar radiation and outgoing infrared radiation. As humans burn fossil fuels, the concentration of greenhouse gases increases, trapping more heat and creating a positive radiative forcing. This forcing is the primary mechanism that alters the climate system and leads to long-term global temperature increases.

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Achieving controlled fusion would fundamentally transform the global energy landscape and provide a truly sustainable power source for centuries.

92. (A) A growing demand for energy driven by industrialization and population growth.
Developing countries are characterized by rapid economic growth, increasing urbanization, and expanding populations, all of which lead to a significant rise in energy demand. As these nations build new infrastructure and industrialize their economies, they require more power for transportation, manufacturing, and residential use. Providing reliable energy access while managing environmental impacts is a key challenge for these countries. This growing demand makes the transition to sustainable and efficient energy systems particularly important for their long-term development.
International cooperation and technology transfer are vital for helping developing nations meet their energy needs sustainably and efficiently today.

93. (A) (A) Solar farms can require large areas of land, which may compete with agriculture or natural habitats.
Utility-scale solar power plants require significant land area to accommodate the thousands of panels needed to generate substantial electricity. This can lead to conflicts over land use, particularly when solar farms are proposed on fertile agricultural land or in sensitive natural ecosystems. While solar energy is clean, its physical footprint is a major factor that must be considered during the planning and environmental assessment process. Efficient land-use strategies and the use of marginal lands can help mitigate these impacts effectively.
Balancing the transition to renewable energy with the protection of land resources and biodiversity is a critical sustainability challenge.

94. (C) Developed countries started the industrial revolution much earlier and have been burning fossil fuels for a longer period.
The historical concentration of carbon dioxide in the atmosphere is primarily the result of over two centuries of industrial activity in developed nations. These countries were the first to utilize coal and oil on a large scale for manufacturing and transportation. While emissions from developing countries are now rising, the cumulative impact of these historical emissions remains a major factor in current climate change. This historical context is essential for understanding global responsibility and the need for international support for climate mitigation.
Recognizing historical emissions is a fundamental principle in international climate negotiations and the quest for global environmental justice today.

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95. (A) Both A and R are true and R is the correct explanation of A.
Radiative forcing is a vital scientific concept used to evaluate how different factors, such as greenhouse gases or aerosols, affect the Earth's energy balance. An increase in the concentration of carbon dioxide traps more outgoing infrared radiation, which creates a positive radiative forcing. This means the planet is gaining more energy than it loses, leading directly to a warming of the global climate. This relationship is the fundamental mechanism that drives global warming and is the basis for climate science.
Understanding radiative forcing allows scientists to quantify the impact of human activities on the climate and predict future temperature trends.

96. (A) Separate the crude oil into various components with different boiling points.
Crude petroleum is a complex mixture of many different hydrocarbons that cannot be used directly in most machines. Refining involves a process called fractional distillation, which separates the oil into various groups, or fractions, based on their boiling points. This process produces usable products like gasoline, diesel, jet fuel, and heating oil. Refining also removes impurities and chemically treats certain fractions to improve their quality and performance. This is essential for turning raw oil into valuable energy resources.
The refining industry is a critical link between oil extraction and the final consumers who rely on these fuels daily.

97. (B) P-4, Q-3, R-1, S-2
Every energy technology has specific environmental impacts that must be managed. Large-scale hydropower can disrupt river ecosystems, while fossil fuel combustion is the

Positive radiative forcing occurs when the Earth's atmosphere traps more of the incoming solar energy, leading to a warming of the climate. The primary cause of this effect in recent history is the rising concentration of greenhouse gases like carbon dioxide, which are released from the burning of fossil fuels. These gases are very effective at absorbing and re-emitting infrared radiation, preventing it from escaping into space. This imbalance is the main driver of modern global warming and associated climate change.
Reducing greenhouse gas emissions is the most direct way to decrease positive radiative forcing and stabilize the Earth's temperature.

110. (C) Hydro
The development of large-scale hydropower projects involves the construction of massive dams and the creation of large reservoirs, which flood significant areas of land. This process leads to habitat fragmentation and disrupts the natural flow of rivers, affecting fish migration and local aquatic ecosystems. While hydro is a renewable energy source, these ecological impacts are a major environmental concern that must be balanced against the need for clean electricity. Sustainable hydro projects focus on minimizing these disruptions through better design and management.
Environmental assessments are critical for identifying and mitigating the negative impacts of hydropower on riverine biodiversity and local communities.

111. (D) Different materials and processes (like photosynthesis or PV cells) respond differently to various wavelengths.
Solar radiation consists of energy across a range of wavelengths, and the way this energy is used depends on the specific part of the spectrum. For instance, plants use visible light for photosynthesis, while thermal collectors are more affected by infrared radiation, and photovoltaic cells are designed to absorb specific bands for electricity. Understanding these spectral characteristics allows for the development of more efficient technologies and a better understanding of how sunlight interacts with the Earth's atmosphere and surface.
Accurate spectral data is essential for optimizing the performance of various solar energy systems and studying environmental processes.

112. (B) Fossil fuels are considered a renewable energy source.
Fossil fuels like coal, petroleum, and natural gas take millions of years to form from buried organic matter, making them non-renewable on a human timescale. Once these resources are extracted and burned, they cannot be replaced within any reasonable period. While they have been the primary source of global energy for over a century, their finiteness and environmental impact are driving the shift toward truly renewable sources like solar and wind. Understanding this distinction is fundamental to the study of sustainable energy.
The transition from finite fossil fuels to renewable energy is a key part of global efforts to ensure long-term sustainability.

113. (B) Viscosity
Viscosity is a physical characteristic that measures a fluid's resistance to flow. For petroleum, this property is critical for its transportation through pipelines, as high-viscosity oil requires more energy and pressure to pump. During refining and transport, the viscosity of different petroleum fractions must be carefully managed, often by heating the oil to make it flow more easily. Understanding and controlling viscosity is essential for the efficient and safe movement of liquid hydrocarbons from the extraction point to the refinery.
Engineers use viscosity data to design pipeline systems and optimize the logistics of the global oil industry.

114. (A) Water molecules
Gas hydrates are solid, ice-like substances formed when gas molecules, primarily methane, are trapped within a cage-like lattice of water molecules. These structures are stable under specific conditions of high pressure and low temperature, such as those found in deep-sea sediments and permafrost regions. The water molecules form a physical host structure that holds the gas without a chemical bond. They represent a potentially massive but technically difficult source of natural gas for the future global energy market.

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a fuel, assuming all the water vapor produced is condensed back into liquid. This condensation releases additional latent heat, which is included in the GCV. This value is typically measured in a laboratory setting using a calorimeter. In contrast, net calorific value excludes this heat, making it a more realistic measure of the energy available in practical systems where condensation does not occur.

Distinguishing between these two values is essential for the accurate thermal design and efficiency analysis of combustion-based power systems.

104. (C) Potential energy to kinetic energy to electrical energy.

Hydropower generation begins with water stored at a high elevation, which possesses significant gravitational potential energy. When this water is allowed to flow down through a penstock, its potential energy is converted into kinetic energy. This moving water then spins a turbine, which is connected to a generator that transforms the mechanical energy into electricity. This process provides a reliable and clean source of renewable power by utilizing the natural movement of water in the global hydrological cycle.

Large-scale hydropower is one of the most established and cost-effective ways to generate renewable electricity on a massive scale.

105. (C) Ocean Thermal Energy Conversion

OTEC stands for Ocean Thermal Energy Conversion, a technology that generates electricity by utilizing the temperature difference between the warm surface water and the cold deep water of the ocean. This thermal gradient is used to drive a heat engine, often by evaporating a working fluid with a low boiling point. OTEC provides a consistent source of renewable energy and is most effective in tropical regions. It represents a significant but technically challenging potential for tapping into the ocean's vast thermal energy.

This technology offers the potential for continuous power generation, independent of daily weather or seasonal climate variations in tropical areas.

106. (A) (a), (b), and (c)

Many energy technologies operate on distinct physical principles. Wind power captures the kinetic energy of air, geothermal energy utilizes the heat from the Earth's interior, and solar photovoltaic cells convert light directly into electricity. While tidal energy is driven by the gravity of the moon and sun, and OTEC uses a temperature gradient rather than salinity, the core principles of wind, solar, and geothermal are correctly identified as harnessing kinetic, thermal, and electromagnetic energy respectively for electricity generation.

Understanding these diverse principles is essential for developing a balanced and sustainable portfolio of renewable energy resources worldwide.

107. (A) Nuclear fusion

Nuclear fusion is the process of joining light atomic nuclei and releases significantly more energy per unit mass than nuclear fission, which involves the splitting of heavy nuclei. This is why fusion is the process that powers the sun and stars. Although fusion is much harder to achieve and control on Earth, its potential for providing a nearly limitless and highly concentrated source of clean energy is a major goal of global research. Fusion also has the advantage of producing less radioactive waste.

Mastering fusion technology would provide a fundamental breakthrough in the search for sustainable and high-density energy sources for humanity.

108. (A) Methane

Biogas is a renewable fuel produced by the breakdown of organic matter in the absence of oxygen, a process known as anaerobic digestion. The primary and most valuable component of biogas is methane, which typically makes up fifty to seventy percent of the total volume. The remaining gas is mostly carbon dioxide, with trace amounts of other gases. Methane gives biogas its combustible properties, making it an excellent source of energy for heating, cooking, and generating electricity in rural and industrial areas.

Producing biogas from waste helps in managing organic refuse while providing a local and sustainable source of energy.

109. (B) An increase in the concentration of greenhouse gases like CO2.

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The solar spectrum consists of various wavelengths, with ultraviolet radiation having the shortest wavelengths and the highest energy per photon. Although visible light and infrared radiation contribute more to the total amount of energy reaching the Earth, ultraviolet photons carry enough energy to cause chemical changes and biological effects, such as sunburn. This high-energy part of the spectrum is largely absorbed by the ozone layer in the atmosphere, protecting life on the surface from its most harmful and intense effects.

Understanding the energy levels across the solar spectrum is essential for both atmospheric science and the development of solar technologies.

122. (C) (a), (c), and (d)

Global carbon dioxide emissions are driven by several factors, including historical industrialization in developed countries and current rapid growth in nations like China. The energy sector remains the largest source of these emissions, primarily due to the burning of fossil fuels for electricity and transportation. While India's total emissions are growing, its per capita emissions are still significantly lower than those in the USA. Recognizing these diverse patterns is vital for developing fair and effective international strategies to combat climate change.

These emission data points are central to international climate negotiations and the goal of reducing global greenhouse gas concentrations.

123. (C) A nuclear fission chain reaction

A nuclear reactor operates by initiating and maintaining a controlled nuclear fission chain reaction. When a heavy nucleus like uranium-235 splits, it releases energy and more neutrons, which then trigger further fission events in neighboring nuclei. By using control rods and moderators, operators can regulate the rate of these reactions to ensure a steady and safe release of heat. This heat is then used to produce steam for electricity generation. This principle is the basis of all modern nuclear power plants.

The precise control of the chain reaction is fundamental to the safety and efficiency of nuclear energy technology worldwide.

124. (B) The mass of living or recently living biological organisms.

Biomass refers to organic material derived from plants, animals, and microorganisms that have recently lived. This includes wood, agricultural crops, and waste products that store energy captured from the sun through photosynthesis. Unlike fossil fuels, which are millions of years old, biomass is a renewable resource because it can be replenished on a human time scale. Biomass can be used directly for energy or converted into various types of biofuels, providing a versatile and sustainable alternative to traditional fossil fuels.

Utilizing biomass for energy is a key part of the global transition toward more sustainable and renewable energy systems today.

125. (C) (C) Increased emissions of sulfur dioxide.

Large-scale hydropower projects have significant environmental impacts such as the submergence of land, displacement of local communities, and alteration of river flows. However, unlike coal-fired power plants, hydropower does not involve combustion and therefore does not produce sulfur dioxide or other air pollutants during its operation. While it has ecological and social challenges, its primary advantage is that it provides a low-carbon and clean source of electricity, making it a major component of the global renewable energy mix.

Balancing the environmental and social costs of large hydro projects with their energy benefits is a key challenge for sustainable development.

126. (B) P-4, Q-2, R-1, S-3

Various energy resources are identified by their unique physical forms and chemical compositions. Shale oil is produced from the solid kerogen found in rock, while coal bed methane is natural gas extracted from coal deposits. Gas hydrates consist of methane molecules trapped within water ice crystals, and petroleum is a familiar liquid mixture of various hydrocarbons. Understanding these different forms is essential for developing the specific extraction and refining technologies needed to utilize each resource effectively and safely.

Each of these energy sources requires different industrial approaches and has distinct environmental and technical challenges for its development.

127. (A) Cube of the wind speed.

Research into gas hydrates focuses on understanding their stability and developing safe methods for their potential extraction and use.

115. (C) Salinity gradient
A solar pond works by maintaining a salinity gradient where the water at the bottom is much saltier and denser than the water at the surface. This gradient prevents convection, which normally allows warm water to rise and lose its heat to the atmosphere. As a result, sunlight reaching the bottom of the pond heats the lower layers to very high temperatures, creating a stable thermal reservoir. This trapped energy can then be used for various low-temperature industrial and heating applications.
Solar ponds provide an integrated way to collect and store solar energy for long periods at a relatively low cost.

116. (B) A material that can sustain a nuclear fission or fusion reaction.
Nuclear fuel consists of isotopes that can undergo nuclear reactions, such as fission or fusion, to release immense amounts of energy. The most common nuclear fuel in use today is uranium-235, which sustains a controlled chain reaction in commercial power plants. In the future, isotopes of hydrogen like deuterium may be used as fuel for nuclear fusion. Unlike fossil fuels, nuclear fuel does not burn in the chemical sense but releases energy from the forces that hold atomic nuclei together.
The handling and processing of nuclear fuel are strictly regulated to ensure safety and prevent the spread of radioactive materials.

117. (A) Pyrolysis
Pyrolysis is a thermochemical process that involves heating biomass in the absence of oxygen to break down complex organic molecules. This process produces a mixture of solid char, liquid bio-oil, and gaseous products, all of which can be used as fuels. Pyrolysis is a versatile way to convert various types of biomass into more concentrated and easily transportable forms of energy. It is one of the key technologies for producing renewable fuels and chemicals from organic waste and plant materials.
This technology offers a pathway for producing high-value energy products while reducing the environmental impact of organic waste disposal.

118. (C) Fossil fuels
Despite the rapid growth of renewable energy, fossil fuels like coal, oil, and natural gas still provide the vast majority of the world's total energy. These carbon-based resources power most of our transportation, heating, and industrial processes, as well as a large portion of global electricity generation. The established infrastructure and high energy density of fossil fuels make them difficult to replace quickly. However, the move toward sustainable energy is driven by the need to reduce the climate impacts associated with fossil fuel combustion.
The global energy transition aims to shift this balance toward cleaner and more sustainable energy sources over the coming decades.

119. (B) Noise and visual impact
The installation of large wind turbines can lead to concerns about noise pollution and the visual impact on the landscape. The rotating blades produce a characteristic sound that some local residents find disruptive, and the massive structures can change the aesthetic quality of rural or coastal areas. While wind power is a clean and renewable resource, managing these social and environmental factors is an important part of the planning and community engagement process for new wind farm projects worldwide.
Modern turbine designs and careful siting are used to minimize these impacts and improve the public acceptance of wind energy.

120. (A) Both A and R are true and R is the correct explanation of A.
The Sun is the ultimate source of energy for most energy forms on Earth, including fossil fuels. Millions of years ago, ancient plants and microorganisms captured solar energy through photosynthesis to build their biomass. When this organic matter was buried and subjected to heat and pressure, it eventually transformed into coal, oil, and natural gas. Therefore, the energy we release today by burning fossil fuels is essentially stored sunlight from the distant past. This connection highlights the fundamental role of solar radiation in the Earth's energy history.
Recognizing the solar origin of fossil fuels helps in understanding the global carbon cycle and the nature of energy resources.

121. (C) Ultraviolet

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radiation and convert it into thermal energy, which is then transferred to a fluid for heating purposes. In contrast, photovoltaic modules use semiconductor materials to convert sunlight directly into electricity through the photoelectric effect. While both are renewable technologies, they provide different types of energy and are used for different applications, from home heating to large-scale power generation.

Choosing between these technologies depends on whether the desired energy output is heat or electrical power for a given application.

134. (C) Kinetic and Potential

Tidal energy generation captures the energy of moving water that results from the gravitational pull of the moon and sun. When tides rise and fall, they create differences in water height, which represents potential energy. Additionally, the flowing water in tidal currents possesses kinetic energy. Both forms of energy can be harnessed using turbines or barrages to generate electricity. Because tidal cycles are determined by astronomical forces, this form of energy is highly predictable and provide a reliable source of renewable power.

The reliability of tidal energy makes it an attractive addition to a diverse and sustainable national energy portfolio in coastal regions.

135. (D) Deuterium

Nuclear fusion involves the joining of light atomic nuclei to release energy, and deuterium, an isotope of hydrogen, is one of the primary fuels for this process. Deuterium is abundant in seawater, making it a potentially limitless source of fuel for future fusion reactors. When combined with other isotopes like tritium under extreme conditions, it releases immense amounts of energy. Unlike uranium, which is used in fission, fusion fuels do not produce long-lived radioactive waste and are widely available to all nations.

Research into deuterium-based fusion is a major global effort to provide safe, clean, and sustainable power for the future of humanity.

136. (B) Fossil fuels continue to dominate the global energy mix despite the growth of renewables.

While the use of solar, wind, and other renewable energy sources is growing rapidly, fossil fuels like coal, oil, and natural gas still provide the vast majority of the world's total energy. This dominance is due to the established infrastructure, high energy density, and historical reliance on these carbon-based resources. The transition to a sustainable energy system is a long-term process that involves replacing this fossil fuel dependence with cleaner alternatives to reduce greenhouse gas emissions and combat climate change globally.

Reducing the global share of fossil fuels is the most critical challenge for achieving international climate and sustainability goals today.

137. (B) Coal, petroleum, and natural gas

The emission of carbon dioxide is a major environmental concern associated with the combustion of fossil fuels such as coal, petroleum, and natural gas. These fuels release carbon that has been stored for millions of years into the atmosphere, leading to an enhanced greenhouse effect and global warming. In contrast, renewable energy sources like solar, wind, and hydro do not emit carbon dioxide during their operation. Reducing our reliance on fossil fuels is the most direct way to lower global greenhouse gas emissions.

Shifting the energy mix away from carbon-intensive fossil fuels is a primary goal of international efforts to address climate change.

138. (A) (a), (b), and (c)

The large-scale use of nuclear energy involves significant considerations, including high initial costs, safety concerns, and the long-term management of radioactive waste. While nuclear plants do not emit greenhouse gases during operation and require water for cooling, it is the economic, social, and technical waste issues that are most commonly cited as challenges for the industry. Addressing these factors is essential for the continued role of nuclear power in a low-carbon energy future and for maintaining public confidence in the technology.

Ensuring the safety and economic viability of nuclear power is a key focus for regulators and the energy industry worldwide.

139. (B) Large-scale land disturbance and habitat destruction.

Surface mining, also known as strip mining, involves the removal of large amounts of soil and rock to access coal deposits near the surface. This process leads to significant land disturbance,

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The power that can be generated from the wind is highly sensitive to changes in wind speed. According to the laws of physics, the energy available is proportional to the cube of the wind velocity. This means that even a small increase in wind speed can lead to a significant increase in the potential power output of a turbine. This relationship is a critical factor in the siting of wind farms, as finding locations with consistently high wind speeds is essential for economic viability.
Understanding this cubic relationship helps engineers optimize the design and performance of wind energy systems for different environmental conditions.

128. (D) It does not produce CO2 during operation.
One of the most significant environmental advantages of nuclear power is that it generates large amounts of electricity without emitting carbon dioxide or other greenhouse gases during its operational phase. This makes it a powerful tool for reducing the carbon footprint of the global electricity sector and combating climate change. While it has challenges related to waste management and safety, its ability to provide a constant and clean energy source is why many countries include nuclear power in their sustainable energy strategies.
The low carbon intensity of nuclear energy is a primary reason for its continued role in the global energy mix today.

129. (B) The causes of climate change.
Radiative forcing is a fundamental concept in climate science that measures how different factors, such as greenhouse gases, aerosols, and land-use changes, alter the Earth's energy balance. It quantifies the difference between incoming solar energy and outgoing infrared radiation, with a positive forcing leading to warming. By analyzing these forcings, scientists can identify the primary drivers of global temperature changes and predict future climate trends. This concept is central to understanding the human impact on the global climate system.
Monitoring and reducing positive radiative forcing is the main goal of global efforts to mitigate climate change and protect the environment.

130. (A) (ii), (i), (iii), (iv)
Energy density measures the amount of energy stored in a given mass of fuel. Wood and other biomass generally have the lowest density, followed by coal, which is a more concentrated solid fuel. Natural gas, being a simple hydrocarbon, has a higher energy content per kilogram than coal. However, nuclear fuels like uranium have an energy density millions of times greater than any chemical fuel because the energy is released from the atomic nucleus. Ranking these fuels helps in evaluating their efficiency for transportation and power generation.
The high energy density of nuclear and fossil fuels is one reason they are so widely used despite their environmental impacts.

131. (B) Absorption and scattering
As solar radiation travels through the Earth's atmosphere, it is modified by various processes that reduce its intensity and change its composition. Atmospheric gases like ozone and water vapor absorb specific wavelengths of energy, while air molecules and small particles like dust scatter radiation in different directions. These interactions are responsible for the color of the sky and the difference between direct and diffuse sunlight. Understanding these effects is essential for predicting the amount of solar energy available at the Earth's surface.
The clarity of the atmosphere directly affects the efficiency of solar power systems and the overall energy balance of the planet.

132. (B) Kerogen
Kerogen is a solid organic material that is trapped within sedimentary rocks, primarily oil shale. It is the precursor to petroleum and natural gas that has not yet been subjected to enough heat and pressure in nature to become liquid or gaseous. To extract energy from these rocks, the kerogen must be heated through a process called pyrolysis to break it down into usable oil and gas. Therefore, the presence and quality of kerogen determine the energy potential of oil shale deposits.
Understanding the chemical properties of kerogen is essential for developing the technology needed to utilize unconventional oil and gas resources.

133. (A) The collector produces heat, while the module produces electricity.
Solar collectors and photovoltaic modules are two distinct technologies used to harness solar energy. Collectors are designed to absorb solar

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primary source of greenhouse gas emissions. Nuclear power generates radioactive waste that requires careful long-term disposal, and large wind farms can pose a risk to local bird and bat populations. Understanding these distinct impacts is essential for developing a balanced energy policy that minimizes environmental harm while providing the reliable power needed for modern society.

A comprehensive approach to energy planning considers both the benefits and the environmental costs of each power generation technology.

98. (D) Petroleum Cracking Reactor (PCR)

Nuclear reactors are designed based on specific technologies like Pressurized Water Reactors, Heavy Water Reactors, and Light Water-Graphite Reactors. These systems are all used to generate heat through nuclear fission for electricity production. A Petroleum Cracking Reactor is not a nuclear reactor; it is an industrial vessel used in oil refineries to break down heavy hydrocarbons into lighter products like gasoline. Distinguishing between nuclear energy systems and chemical refining equipment is essential for understanding different types of industrial and power technologies.

Each type of reactor has its own unique engineering challenges and safety features for handling radioactive materials and processes.

99. (A) Electromagnetic radiation

The Sun emits energy across a broad spectrum of wavelengths, which travels through the vacuum of space to reach the Earth. This form of energy is known as electromagnetic radiation, and it includes ultraviolet, visible light, and infrared bands. When this radiation interacts with the Earth's atmosphere and surface, it provides the heat and light necessary for life and powers the planetary climate system. Understanding the nature of this radiation is fundamental for harnessing solar energy and studying global energy balance.

Solar radiation is the primary source of energy that drives almost all biological and physical processes on our planet today.

100. (B) (ii), (iv), (i), (iii)

A typical coal-fired power plant operates through a series of energy transformations. First, coal is burned in a boiler to heat water and create steam. Next, this high-pressure steam is directed toward a turbine, causing it to spin. The spinning turbine then drives a generator, which converts the mechanical energy into electricity. This sequence of steps is designed to maximize the conversion of the chemical energy stored in the coal into a versatile and widely used form of electrical power.

Modern power plants use advanced technologies to improve the efficiency and reduce the environmental impact of this combustion-based process.

101. (A) State of matter at ambient temperature and pressure

Fossil fuels are primarily classified as solid, liquid, or gas based on their natural state of matter. Coal is a solid rock, petroleum is a liquid mixture, and natural gas is a gaseous fuel. These physical states are a direct result of the geological processes and organic materials that formed them over millions of years. This classification is fundamental for determining how each fuel is extracted, transported, and utilized in various industrial and domestic energy applications across the globe.

Understanding these physical states is essential for designing the infrastructure and technology needed to manage global energy resources effectively.

102. (A) Methane that is adsorbed onto the solid matrix of coal.

Coal bed methane is an unconventional form of natural gas that is found within coal deposits. During the process of coal formation, methane is produced and remains trapped on the surface of the coal molecules or within the tiny fractures in the seam. This gas can be extracted by drilling into the coal and removing the surrounding water, which lowers the pressure and allows the gas to flow. It is an important and increasingly used source of clean-burning energy.

Developing this resource requires careful management of the water produced during the extraction process to protect the environment.

103. (C) GCV assumes that the water vapor from combustion is fully condensed to recover its latent heat.

The gross calorific value is a measure of the total heat released during the complete combustion of

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destroys local ecosystems, and results in the loss of biodiversity. While mining companies are often required to reclaim the land afterward, the original habitat is permanently altered. This environmental impact is a major drawback of coal mining and highlights the importance of transitioning to cleaner and less destructive energy sources.
Sustainable energy planning must consider the full environmental cost of energy extraction, including the impact on land and biodiversity.

140. (A) Both A and R are true and R is the correct explanation of A.
India's rising carbon dioxide emissions are a direct result of its rapid economic development and the need to provide electricity to a growing population. As the country industrializes and urbanizes, its demand for energy increases significantly. Currently, a large portion of this demand is met by fossil fuels, particularly coal, which leads to higher emissions. Balancing the need for economic growth and energy access with environmental sustainability is the primary challenge for India's national energy policy and its international climate commitments.
International support for clean energy technology and financing is vital for helping India achieve its sustainable development and climate goals.

141. (B) Carbon content and volatile matter
The energy content of coal, measured as its calorific value, is primarily determined by its chemical composition. Higher concentrations of fixed carbon provide more energy, while the amount of volatile matter affects how easily the coal ignites and burns. As coal progresses through different ranks from lignite to anthracite, its carbon content increases while its moisture and volatile matter decrease. Understanding these properties is essential for the commercial grading of coal and for optimizing its use in industrial boilers and power plants.
Analyzing the carbon and volatile matter in coal allows for more efficient combustion and better management of the resulting emissions.

142. (B) Harnessing heat from the Earth's interior.
Geothermal energy extraction utilizes the heat naturally stored within the Earth's crust, which comes from the decay of radioactive elements and the planet's original formation. This heat can be accessed by tapping into underground reservoirs of hot water and steam, which are then used to generate electricity or provide direct heating. Geothermal energy is a reliable and continuous renewable resource that is not affected by weather conditions. It provides a constant baseload of power and is a sustainable alternative to fossil fuels.
Expanding the use of geothermal energy is an important part of global efforts to develop a diverse and sustainable energy mix.

143. (C) Natural gas
Biomass is organic material derived from living or recently living organisms, such as wood, agricultural waste, and municipal refuse. Natural gas, however, is a fossil fuel formed from organic matter that was buried millions of years ago. While natural gas is a hydrocarbon fuel, it is not considered biomass because of its ancient geological origin. Understanding the difference between contemporary biomass and fossil-based energy sources is essential for evaluating the sustainability and carbon footprint of different types of fuels used in the global economy.
Distinguishing between renewable biomass and non-renewable fossil fuels is fundamental to the study of energy and the environment.

144. (B) Containing the extremely high-temperature plasma required for the reaction.
Nuclear fusion requires temperatures of millions of degrees to overcome the electrostatic repulsion between atomic nuclei and allow them to fuse. At these extreme temperatures, the fuel exists as a plasma that must be contained and stabilized using powerful magnetic fields or lasers. Maintaining these conditions long enough to produce net energy is the primary technical challenge for developing practical fusion power. While the potential rewards of clean and limitless energy are immense, controlled fusion remains a complex and ongoing engineering goal for researchers.
Achieving successful and sustainable fusion energy would be a transformative development for the global energy landscape and climate goals.

145. (B) To convert the kinetic or thermal energy of a moving fluid into rotational mechanical energy.
A turbine is a fundamental mechanical device used in most types of power plants to transform

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the energy of a moving fluid into rotational work. Whether the fluid is steam from coal or nuclear heat, moving water in a hydro plant, or wind in a wind farm, it strikes the turbine blades and causes them to spin. This rotational energy is then used to drive a generator that produces electricity. The turbine is the critical link in the process of converting natural or thermal energy into power.

Modern turbine designs are highly engineered to maximize the efficiency of energy conversion for different types of power generation systems.

146. (A) It cannot provide a consistent power supply and is dependent on river flow.

Run-of-the-river hydropower plants divert a portion of a river's flow to generate electricity without the use of a large reservoir for storage. While this reduces the environmental impact compared to large dams, it also means that the power output is directly dependent on the immediate flow of the river. During periods of low rainfall or seasonal changes, the power generation can decrease significantly. This lack of storage makes it more difficult to match electricity production with changes in consumer demand throughout the day and year.

Understanding the trade-offs between storage-based and run-of-the-river hydro is essential for effective and sustainable renewable energy planning.

147. (B) Geothermal energy originates from the Earth's core.

Geothermal energy is the heat naturally present within the Earth, originating from the decay of radioactive elements and the residual heat from the planet's formation. This energy is not derived from the sun, but from the Earth's own internal processes. In contrast, wind and tidal energy are forms of kinetic energy driven by solar heating and gravitational forces, respectively. Recognizing the unique source of geothermal energy is essential for understanding how this reliable and continuous renewable resource can be harnessed for power generation.

Geothermal power provides a stable and clean source of energy that is independent of atmospheric and weather conditions.

148. (B) A device designed to capture solar radiation and convert it into thermal energy.

A solar collector is a specialized device used to absorb solar radiation and transform it into heat. It typically consists of a dark surface that absorbs sunlight and transfers the resulting thermal energy to a working fluid like water or air. This heated fluid can then be used for domestic water heating, space heating, or industrial processes. Unlike solar panels that produce electricity, collectors are focused on the efficient capture and use of solar heat, providing a sustainable thermal energy solution.

Using solar collectors is an effective way to reduce the use of fossil fuels for heating applications in various climates.

149. (A) (A) P-3, Q-4, R-1, S-2

Different energy technologies and resources are associated with specific technical terms and components. The energy content of coal is measured by its calorific value, while solar photovoltaic cells utilize the photovoltaic effect to generate electricity. Control rods are essential for regulating the chain reaction in a nuclear reactor, and gasification is a process used to convert solid biomass into a combustible gas. Understanding these relationships is fundamental to the study of modern energy systems and the principles that govern their operation and efficiency.

Correctly identifying these terms helps in the clear communication and analysis of diverse energy technologies and their environmental impacts.

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150. (A) The intermittency of the power source (day/night, clouds).

A major challenge for large-scale solar energy is that the power output is intermittent, as it depends on the availability of sunlight. Solar panels do not produce electricity at night, and their output can be significantly reduced by cloud cover and weather changes. This intermittency requires the use of energy storage systems or a diverse mix of power sources to ensure a consistent and reliable supply of electricity to the grid. Managing this variability is a key focus for modern energy planners and engineers.

Developing cost-effective energy storage solutions is essential for the continued growth and integration of solar power into the global grid.

151. (C) Electromagnetic radiation

The Sun provides energy to the Earth in the form of electromagnetic radiation, which travels through space and covers a range of wavelengths, including ultraviolet, visible light, and infrared. When this radiation reaches our planet, it is absorbed by the atmosphere and surface, providing the heat and light necessary for all biological and physical processes. Understanding the nature of this radiation is fundamental for developing solar energy technologies and for studying the Earth's climate and overall energy balance on a global scale.

Solar radiation is the primary energy source that sustains life and drives the planetary systems we depend on every day.

152. (B) A complex mixture of hydrocarbons

Crude petroleum is a fossil fuel that exists as a complex liquid mixture of various hydrocarbons, along with small amounts of other organic compounds. These hydrocarbons range in size and complexity, which determines the physical and chemical properties of the oil. In a refinery, this mixture is separated into different components like gasoline, diesel, and jet fuel through processes like fractional distillation. Understanding the composition of petroleum is essential for its efficient refining and for managing its use as a primary global energy resource.

The chemical diversity of petroleum makes it a versatile source for both fuels and various essential industrial chemical products.

153. (B) The technological difficulty and potential environmental risks of extraction.

Gas hydrates represent a vast potential source of natural gas, but extracting them safely from deep oceanic sediments or permafrost is a major technical challenge. Because they are only stable under high pressure and low temperature, any disturbance could lead to an uncontrolled release of methane, which is a potent greenhouse gas. Developing reliable and environmentally safe extraction methods is the primary hurdle for the commercial use of this resource. Research continues to focus on understanding hydrate stability and minimizing the risks of their development.

The potential climate impact of methane release makes the careful management of gas hydrate resources a global environmental priority.

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154. (D) Hydrogen

The difference between gross and net calorific values is primarily due to the heat of vaporization of the water produced during combustion. When hydrogen in a fuel burns, it combines with oxygen to form water vapor. In gross calorific value, this vapor is condensed and its latent heat is included, while in net calorific value, the heat is lost as the vapor remains in a gaseous state. Therefore, fuels with a high hydrogen content, like natural gas, show the largest difference between these two energy measurements.

Understanding the role of hydrogen in combustion is essential for accurate thermal calculations and the design of energy-efficient systems.

155. (C) Ocean Thermal Energy Conversion (OTEC)

OTEC is a renewable energy technology that generates power by utilizing the temperature difference, or gradient, between the warm surface water and the cold deep water of the ocean. This thermal gradient drives a heat engine that produces electricity. Unlike wind or hydro power, which rely on kinetic or potential energy, OTEC depends on the consistent thermal storage capacity of the tropical oceans. It provides a reliable and continuous source of power that is independent of daily weather or seasonal changes in climate.

OTEC represents a significant opportunity for sustainable energy production in tropical and subtropical coastal regions around the world today.

156. (B) (b) and (c)

Modern nuclear energy production is based on fission, and thorium is a valuable fertile material that can be used to produce fissile fuel. In a nuclear reactor, the moderator is essential for slowing down fast neutrons, which significantly increases the efficiency of the fission process and helps maintain a stable chain reaction. While nuclear power is a low-carbon energy source, it still has environmental implications related to waste and mining. Correctly identifying these technical principles is vital for understanding the operation and role of nuclear power.

The use of control rods is a primary safety and operational feature of all commercial nuclear fission reactor designs today.

180. (A) Both A and R are true and R is the correct explanation of A.
Bioenergy is often considered carbon neutral because the carbon dioxide released during its combustion was recently removed from the atmosphere by plants during their growth. This creates a closed loop where the carbon is recycled rather than being added as new carbon to the climate system, as is the case with fossil fuels. If the biomass is managed and harvested sustainably, it provides a renewable and low-carbon alternative for heating and power. This characteristic makes bioenergy an important part of global climate change mitigation strategies.
Sustainable bioenergy production is a key component of the transition to a more circular and sustainable global energy economy.

181. (C) Electromagnetic waves
Solar radiation is the energy emitted by the Sun in the form of electromagnetic waves that travel through the vacuum of space to reach the Earth. This radiation covers a wide spectrum of wavelengths, including ultraviolet, visible light, and infrared. When these waves interact with our atmosphere and surface, they provides the energy necessary for life and power the global climate and weather systems. Understanding the electromagnetic nature of solar energy is fundamental for harnessing it through various solar thermal and photovoltaic technologies used today.
Solar energy is the primary and original source of power for almost all physical and biological processes on our planet.

182. (C) Natural Gas
Natural gas is considered the cleanest-burning fossil fuel because it has the highest hydrogen-to-carbon ratio among all carbon-based fuels. This chemical composition means that it produces significantly less carbon dioxide per unit of energy released compared to coal or petroleum. It also produces fewer other pollutants like sulfur dioxide and particulate matter. While it is still a fossil fuel and a source of greenhouse gas emissions, its relative cleanliness makes it an important transition fuel in global efforts to reduce the carbon footprint of energy.
Increasing the use of natural gas in place of coal can help lower national and global greenhouse gas emissions in the short term.

183. (D) Solar collector - Photoelectric effect
Energy generation technologies operate on specific physical and chemical principles. Hydropower uses gravitational potential energy, wind power uses kinetic energy, and geothermal energy uses the Earth's internal heat. A solar collector, however, is designed to absorb solar radiation and convert it into thermal energy, not electricity through the photoelectric effect. The photoelectric effect is the principle behind photovoltaic modules. Correctly identifying these principles is fundamental for understanding how different renewable resources are harnessed to provide sustainable energy for modern society and its various needs.
Accurate knowledge of energy principles is essential for the effective design and integration of diverse renewable energy systems worldwide.

184. (B) Light nuclei and extremely high temperatures.
Nuclear fusion is the process of joining light atomic nuclei, such as hydrogen, to form a heavier nucleus like helium. This reaction requires extremely high temperatures and pressures to overcome the natural repulsion between positively charged nuclei. Under these conditions, the nuclei move with enough kinetic energy to fuse together, releasing an immense amount of energy. Fusion is the process that powers the sun and stars, and achieving controlled fusion on Earth is a major goal for providing safe and nearly limitless clean energy.
Research into high-temperature plasma confinement is a key part of global efforts to develop practical and sustainable fusion power.

185. (C) Differences in levels of industrialization, infrastructure, and per capita income.
The energy use pattern of a country is most strongly influenced by its level of economic development and industrialization. Developed nations have established infrastructures, high levels of automobile ownership, and energy-intensive lifestyles, leading to high per capita energy consumption. In contrast, developing nations like India have a growing but still lower

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of hydrocarbons we know as crude oil. Because this process takes so long, petroleum is a non-renewable resource. Its geological origin is the reason it stores concentrated energy from the sun that was captured by ancient life.
Understanding the biological and geological history of petroleum is essential for its discovery, extraction, and management as an energy source.

163. (B) Pyrolysis
Pyrolysis is a thermochemical process used to extract energy from oil shale by heating the rock in the absence of oxygen. This heat breaks down the solid organic material, known as kerogen, into liquid oil and gaseous hydrocarbons. Pyrolysis is a key technology for utilizing unconventional oil resources that cannot be produced using traditional drilling methods. While it is more energy-intensive and complex than conventional extraction, it provides a way to tap into vast potential energy reserves found in shale formations around the world.
Developing efficient and environmentally responsible pyrolysis technology is a major goal for the future of the unconventional energy industry.

164. (C) The Photovoltaic effect
The fundamental principle of a photovoltaic module is the photovoltaic effect, which allows semiconductor materials to convert sunlight directly into electricity. When photons from the Sun strike the surface of the solar cells, they provide enough energy to release electrons, creating a flow of electric current. This process provides a clean and silent way to generate power without moving parts or emissions. PV technology is a cornerstone of the global transition to renewable energy and is used for a wide range of applications today.
The continuous improvement in PV efficiency and cost is making solar energy increasingly competitive with traditional fossil fuel-based power.

165. (B) The fission of one nucleus releases neutrons that cause the fission of other nuclei.
In a nuclear reactor, a chain reaction occurs when the neutrons released by the fission of one nucleus go on to trigger fission in neighboring nuclei. This process results in a self-sustaining series of reactions that release a steady amount of energy. Controlling the rate of this chain reaction is essential for safe power generation and is achieved using materials that absorb excess neutrons. This principle allows a small amount of nuclear fuel to provide a large and consistent supply of thermal energy for electricity.
The ability to maintain a controlled and stable chain reaction is the defining feature of commercial nuclear energy technology worldwide.

166. (A) Carbon neutral, if the biomass is sourced sustainably.
A major environmental advantage of bioenergy is its potential to be carbon neutral. The carbon dioxide released during the combustion of biomass is approximately equal to the amount of carbon dioxide absorbed by the plants during their growth through photosynthesis. If the biomass is harvested and replaced sustainably, the process creates a closed carbon loop that does not add new carbon to the atmosphere. This makes bioenergy a valuable tool for reducing greenhouse gas emissions and achieving climate goals in various energy sectors.
Ensuring sustainable land management and biomass sourcing is essential for realizing the full climate benefits of bioenergy technology.

167. (A) Release of methane from decomposing submerged vegetation in the reservoir.
When large areas of land are flooded to create reservoirs for hydropower, the submerged vegetation and organic matter begin to decompose under anaerobic conditions. This process can lead to the production and release of methane, which is a potent greenhouse gas. This is a significant environmental concern for some large-scale hydro projects, particularly in tropical regions. While hydropower is a low-carbon energy source, managing these reservoir emissions is an important part of assessing the overall environmental impact of hydroelectric development.
Monitoring and mitigating greenhouse gas emissions from reservoirs is a key component of sustainable hydropower management and planning.

168. (D) China
China is currently the world's largest consumer of energy and the single largest annual emitter

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The safe and efficient operation of nuclear reactors depends on the precise integration of these physical and chemical principles.

157. (D) Fractional distillation of crude oil
Bioenergy is produced from organic materials through various methods such as anaerobic digestion, fermentation, and direct combustion. These processes utilize the energy stored in biomass, which is a renewable resource. Fractional distillation of crude oil, however, is an industrial refining process used to separate fossil petroleum into its different components like gasoline and diesel. It is not a method for producing energy from biomass. Understanding the distinction between biomass conversion and fossil fuel refining is essential for studying different energy systems and their sustainability.
Each bioenergy production method is chosen based on the type of feedstock and the desired form of usable energy.

158. (B) The change in net energy balance at the top of the atmosphere.
Radiative forcing is a term used by climatologists to quantify how various factors, such as greenhouse gases or aerosols, alter the balance of energy entering and leaving the Earth's atmosphere. It represents the net change in the energy irradiance at the tropopause, measured in watts per square meter. A positive forcing value indicates that the Earth is retaining more energy, leading to global warming. This concept is central to identifying the drivers of climate change and predicting future temperature trends globally.
Scientific assessments use radiative forcing to compare the warming potential of different substances and human activities on the climate.

159. (B) Coal
India's current energy use pattern is characterized by a heavy reliance on coal, which provides the majority of the country's electricity and industrial power. This dependence is due to India's significant domestic coal reserves and the need for affordable and reliable energy to support its rapid economic growth. While the use of renewable energy is increasing, coal remains the primary component of India's energy mix. Managing the environmental impacts of coal while ensuring energy security is a major challenge for India's sustainable development and climate policy.
Transitioning toward cleaner energy sources while maintaining economic growth is a central goal of India's long-term energy strategy today.

160. (A) Both A and R are true and R is the correct explanation of A.
Every energy source, whether renewable or non-renewable, has some environmental implications that must be considered. Large solar and wind farms require significant land area and resources for manufacturing, while hydropower dams can alter river ecosystems and affect biodiversity. Even though these sources are much cleaner than fossil fuels during operation, their full lifecycle impact must be managed. Recognizing these trade-offs is essential for developing a truly sustainable and balanced energy system that minimizes environmental harm while providing the reliable power society needs.
A comprehensive environmental assessment of all energy technologies is necessary for making informed and responsible energy and climate decisions.

161. (B) Light
The visible portion of the solar radiation spectrum consists of the wavelengths that the human eye can detect and perceive as light. This band of energy is essential for vision and is the primary driver of photosynthesis in plants, which forms the basis of almost all food chains on Earth. While the Sun also emits ultraviolet and infrared radiation, it is the visible light that provides the illumination necessary for most biological activities. Understanding this part of the spectrum is fundamental for studying both biology and solar energy.
Visible light plays a central role in the Earth's climate system and the daily lives of all living organisms globally.

162. (A) The remains of ancient marine microorganisms.
Petroleum is classified as a fossil fuel because it was formed over millions of years from the buried remains of ancient marine microorganisms like algae and plankton. Under the conditions of high pressure and temperature found deep within the Earth's crust, this organic matter slowly transformed into the complex mixture

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A key difference between developed and developing countries is that individuals in developed nations typically have much higher per capita carbon dioxide emissions. This is due to more energy-intensive lifestyles, higher levels of industrialization, and widespread use of personal transportation in affluent societies. While total emissions from some developing countries are rising due to their large populations, the per capita impact remains significantly lower. This distinction is a central point in international climate negotiations regarding fair and equitable responsibility for reducing global emissions.
Addressing the high per capita emissions in developed countries is essential for meeting global climate targets and ensuring environmental justice.

175. (D) Significant risk of large-scale explosions.
While the large-scale exploitation of solar energy involves land use, water consumption for cleaning, and lifecycle emissions from manufacturing, it does not carry a significant risk of large-scale explosions. Solar photovoltaic and thermal systems are generally very safe to operate compared to some other energy technologies. The primary environmental and social impacts of solar power are related to its physical footprint and the resources used during its production. Understanding these factors is important for ensuring that the growth of solar energy is truly sustainable.
Solar energy is one of the safest and cleanest technologies available for large-scale renewable electricity generation today.

176. (A) (A) P-3, Q-2, R-1, S-4
Every energy source utilizes a specific conversion process to produce usable power. Coal power plants rely on combustion to release chemical energy, while solar photovoltaic cells use the photoelectric effect to generate electricity directly. Wind turbines convert the kinetic energy of moving air into mechanical and then electrical energy, and nuclear reactors use the process of nuclear fission to generate heat. Recognizing these primary conversion processes is fundamental to the study of energy systems and for comparing the efficiency and environmental impact of different technologies.
Understanding these physical and chemical principles allows for the development and optimization of diverse and sustainable energy resources.

177. (A) (i), (ii), (iii), (iv)
Coal rank is a classification that reflects the degree of geological transformation from peat to anthracite. Peat is the lowest rank, representing the initial stage of coal formation. Lignite is the next rank, followed by bituminous coal, which is the most common type used for power generation. Anthracite is the highest rank, characterized by the highest carbon content and energy density. This sequence shows how increasing heat and pressure over millions of years produce a more concentrated and valuable solid fuel source.
Identifying the rank of coal is essential for determining its commercial quality and the most efficient way to use it.

178. (B) Tropical and subtropical regions with warm surface waters
Ocean Thermal Energy Conversion technology is geographically limited to tropical and subtropical regions because it requires a large and consistent temperature difference between surface and deep ocean waters. This thermal gradient is only found in areas where the sun provides year-round heating to the ocean's upper layers. Without this significant temperature gap, OTEC systems cannot function efficiently to generate electricity. This site-specific nature means that OTEC is a specialized renewable energy option for coastal and island nations in the tropics.
Developing OTEC in suitable regions provides a unique opportunity for continuous and sustainable power generation from the world's oceans.

179. (C) Using control rods to absorb neutrons
The chain reaction in a nuclear reactor must be carefully controlled to ensure a steady and safe power output. This is achieved by using control rods made of materials that absorb neutrons, such as boron or cadmium. By moving these rods in and out of the reactor core, operators can precisely regulate the number of neutrons available to cause further fission events. This control mechanism is fundamental to the safe operation of nuclear power plants and allows for the quick shutdown of the reactor if necessary.

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greenhouse effect. The primary cause is the rising concentration of greenhouse gases like carbon dioxide, which increase the positive radiative forcing of the climate system. This warming is the main driver of broader climate change, leading to melting glaciers, rising sea levels, and more extreme weather patterns. Reducing emissions and shifting to cleaner energy are the most important steps for mitigating global temperature rise.

International cooperation to limit global warming is essential for protecting ecosystems and human societies from the impacts of climate change.

192. (C) Their intermittency and the need for energy storage

A primary challenge for the widespread adoption of solar and wind power is that their output is not constant and depends on the availability of sunlight and wind. This intermittency makes it difficult to provide a reliable and consistent supply of electricity to the grid at all times. To overcome this, the development of cost-effective and large-scale energy storage systems is essential. Managing the variability of these renewable resources is a major focus for energy engineers and planners as they work to build a more sustainable and resilient power system.

Advances in battery technology and grid management are key to integrating higher levels of renewable energy into our power supply.

193. (B) P-3, Q-1, R-2, S-4

Fossil fuels and unconventional oil resources are defined by their primary forms and chemical characteristics. Coal exists as a solid carbonaceous material, while natural gas is predominantly composed of methane. Petroleum is a well-known liquid mixture of hydrocarbons, and shale oil is an unconventional fuel derived from the organic kerogen trapped in rock. Recognizing these different forms is fundamental for understanding how these resources were formed and for developing the specific industrial technologies needed to extract, process, and utilize each one effectively and safely.

Each fuel type presents unique technical and environmental challenges that must be addressed to ensure a secure and sustainable energy supply.

194. (B) Methane

Natural gas is a fossil fuel that consists primarily of methane, which is the simplest and most abundant hydrocarbon molecule. In most natural gas reserves, methane accounts for eighty percent or more of the total volume, giving the gas its combustible properties and high energy content. Other hydrocarbons like ethane and propane are also present in smaller amounts. Because methane is the main component, natural gas is considered a relatively clean-burning fuel and is widely used for heating, cooking, and generating electricity.

Methane's role as the primary constituent of natural gas makes it a critical component of the global energy and climate landscape today.

195. (B) The water vapor produced is condensed back to liquid water.

The gross calorific value is a measure of the total amount of heat released during the complete combustion of a fuel, assuming that all the water vapor formed is condensed back into a liquid state. This condensation process releases additional latent heat, which is included in the GCV measurement. While this value is useful for comparing fuels in a laboratory setting, it is often higher than the heat actually available in most practical systems where the water remains as vapor and its heat is lost.

Understanding the difference between gross and net calorific values is essential for the accurate thermal design and analysis of combustion systems.

196. (B) The temperature difference between warm surface and cold deep ocean water.

OTEC technology operates by using a heat engine that utilizes the thermal gradient between the sun-warmed surface water and the cold water found deep in the ocean. This temperature difference is used to evaporate and then condense a working fluid, creating the pressure necessary to drive a turbine and generate electricity. This process provides a continuous and reliable source of renewable energy that is not affected by weather or daily cycles. OTEC is most suitable for tropical regions where this temperature difference is greatest.

Harnessing the ocean's thermal energy is a promising way to provide sustainable and

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level of energy access and different industrial priorities. As economies grow and infrastructure expands, their energy needs and patterns of use also change, presenting significant challenges and opportunities for sustainable and efficient energy planning.

Understanding these socio-economic drivers is essential for developing effective national and international energy and climate policies for the future.

186. (A) The emission of CO_2, SOx, NOx, and particulate matter.

The combustion of coal is a major environmental concern because it releases a range of pollutants into the atmosphere. This includes carbon dioxide, a primary greenhouse gas, as well as sulfur and nitrogen oxides that contribute to acid rain and smog. Coal burning also produces significant amounts of particulate matter, which can have negative impacts on human health and local air quality. While coal provides a substantial portion of global energy, managing these diverse emissions is a critical challenge for the energy industry and environmental regulators.

Reducing coal emissions through better technology and the shift to cleaner fuels is a major goal for protecting the global environment.

187. (A) Changes to local microclimates.

Large-scale wind energy developments can influence local microclimates by altering the flow of air near the Earth's surface. The rotation of the turbine blades can increase the mixing of different air layers, which can affect temperature and moisture levels on the ground in the immediate vicinity of the wind farm. While these effects are generally small compared to the global climate benefits of wind power, they are an important consideration in environmental impact studies. Understanding these local impacts is part of ensuring that wind energy is developed sustainably.

Continuous research into the environmental effects of wind farms helps in optimizing their design and minimizing any negative local impacts.

188. (A) (a), (b), and (d)

Energy sources are classified as renewable or non-renewable based on the timescale of their formation and use. Fossil fuels are non-renewable because they take millions of years to form, while solar and biomass are considered renewable because they can be replenished quickly. Uranium, although widely available, is a finite mineral resource and is therefore not considered renewable. Correctly identifying the nature of these diverse energy resources is fundamental for developing sustainable energy policies and for ensuring long-term energy security on a national and global scale.

The shift from finite and non-renewable fuels to sustainable and renewable resources is a primary goal of global energy transitions today.

189. (B) Joules per cubic meter or BTUs per cubic foot

The energy content of natural gas is typically measured in terms of heat per unit of volume, as it is a gaseous fuel. Common units used in the energy industry include Joules per cubic meter or British Thermal Units per cubic foot. These measurements allow for the comparison of different gas samples and are used for commercial valuation and for designing heating and power systems. Knowing the energy density of natural gas is essential for its efficient and safe use in various industrial and residential applications.

Standardizing the measurement of gas energy content ensures fair trade and accurate performance analysis in the global energy market today.

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190. (C) To transfer heat from the reactor to the turbine.

In a nuclear power plant, the energy released from fission is used to heat a coolant, which then transfers that thermal energy to water to produce steam. This steam is the working fluid that drives the turbine to generate electricity. Whether the steam is produced directly in the reactor or in a separate steam generator, its role is to carry the nuclear heat to the mechanical part of the system. This process is essential for converting atomic energy into the electrical power we use every day.

The efficient transfer of heat is a critical component of nuclear reactor design and ensures the safe and productive use of nuclear fuel.

191. (B) Global warming

Global warming refers to the long-term increase in the Earth's average surface temperature due to human activities that enhance the natural

commercial valuation of coal and for optimizing its performance in power plants and boilers.
Analyzing these properties allows for more efficient combustion and better management of the residues and emissions produced by burning coal.

203. (B) The risk of uncontrolled methane release during extraction.
A major hurdle for gas hydrate exploitation is that they are only stable under specific conditions of high pressure and low temperature. Any attempt to extract the gas could destabilize the hydrate structure, leading to an uncontrolled and potentially dangerous release of methane. Methane is a potent greenhouse gas, so managing this risk is a critical technical and environmental challenge for researchers and engineers. Developing safe and reliable extraction methods is the primary focus of international efforts to unlock the energy potential of gas hydrate deposits.
Ensuring the environmental safety of gas hydrate extraction is a top priority for the sustainable development of this vast resource.

204. (C) (a), (b), and (d)
Various energy generation technologies operate based on distinct physical and natural principles. Solar collectors use a fluid to transfer thermal energy, while photovoltaic modules convert light directly into electricity. Wind power is also a form of solar energy because the winds are driven by the uneven solar heating of the atmosphere. Correctly identifying these principles is fundamental for understanding how different renewable resources are harnessed to provide sustainable and reliable power for modern society and its diverse energy needs across various geographic regions.
Accurate knowledge of these principles is essential for the effective design and integration of different renewable energy systems globally.

205. (B) Nuclear Fusion
Nuclear fusion is the process where light atomic nuclei, such as isotopes of hydrogen, are joined together to form a heavier nucleus like helium, releasing immense amounts of energy. This reaction requires extreme temperatures and pressures and is the fundamental power source for the Sun and other stars. While fusion is much harder to achieve and control on Earth than fission, its potential for providing a nearly limitless and clean source of energy is a major goal for global research and development in the sustainable energy sector.
Mastering controlled fusion would provide a transformative and truly sustainable power source for the future of humanity and the planet.

206. (C) Anaerobic digestion
Anaerobic digestion is a biological process that uses microorganisms to break down organic matter in the absence of oxygen, producing a mixture of methane and carbon dioxide known as biogas. This method is particularly suitable for processing wet biomass such as animal manure, sewage, and food waste. The resulting biogas can be used for cooking, heating, or generating electricity, providing a sustainable and clean source of energy while also managing waste. This technology is a key component of circular and decentralized energy systems in many regions.
Producing bioenergy from waste through anaerobic digestion helps in reducing environmental pollution while providing a valuable renewable fuel source.

207. (A) Gaining energy, leading to warming.
Positive radiative forcing occurs when the Earth's atmosphere traps more of the incoming solar energy than it radiates back into space. This imbalance means that the entire Earth system is gaining energy, which leads directly to a warming of the global climate. The primary driver of this effect in recent history is the rising concentration of greenhouse gases like carbon dioxide, which are released from human activities like fossil fuel burning. Reducing this positive forcing is the most critical challenge for stabilizing the global temperature and protecting the environment.
Monitoring and reducing positive radiative forcing is the main goal of international efforts to mitigate global warming and climate change.

208. (C) Renewable energy sources like solar and wind.
The global energy use pattern is currently shifting as many countries increase their share of renewable energy sources like solar and wind. This transition is driven by the need to reduce greenhouse gas emissions, improve energy security, and take advantage of the falling costs

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consistent power for coastal and island communities globally.

197. (B) Uranium-235
Uranium-235 is a fissile material that is the primary fuel used in most of the world's commercial nuclear reactors. It has the unique ability to sustain a controlled nuclear fission chain reaction when struck by neutrons, releasing large amounts of energy in the process. Because natural uranium contains only a small percentage of this isotope, it is often enriched to increase its concentration for use in fuel rods. Managing uranium-235 safely is essential for the reliable production of low-carbon electricity from nuclear energy sources worldwide.
The careful control of fissile materials is fundamental to the security and safe operation of the global nuclear energy industry.

198. (A) Both A and R are true and R is the correct explanation of A.
In most industrial and practical applications, the exhaust gases from combustion are released at high temperatures, which prevents the water vapor from condensing. As a result, the latent heat of vaporization is not recovered and is lost to the atmosphere. This means that the net calorific value provides a more realistic measure of the actual heat available for work in these systems compared to the gross calorific value. Recognizing this reality is essential for the accurate calculation of fuel efficiency and thermal performance in real-world power and heating devices.
Engineers consistently use net calorific values to evaluate the performance of engines and boilers in practical, operational environments.

199. (B) It can be potentially carbon-neutral.
The primary environmental benefit of bioenergy is its potential to be carbon-neutral over its lifecycle. The carbon dioxide released when biomass is burned was recently captured from the atmosphere by plants through photosynthesis. If the biomass is harvested and replanted sustainably, this creates a closed carbon cycle that does not add new net carbon to the atmosphere. This makes bioenergy a valuable tool for reducing greenhouse gas emissions and meeting climate goals, especially when it replaces carbon-intensive fossil fuels in heating, transportation, and electricity generation.
Sustainable bioenergy production is a key part of global efforts to reduce the carbon footprint of the modern energy system.

200. (A) Land use for solar farms, and life-cycle impacts of manufacturing panels.
The large-scale development of solar energy involves several environmental and social considerations, primarily related to the land area needed for solar farms and the environmental impact of manufacturing the panels. Solar farms can require vast areas of land, which may compete with other uses or affect local ecosystems. Additionally, the production of solar cells involves the use of energy and materials that have their own environmental footprint. Understanding these lifecycle impacts is essential for ensuring that the transition to solar energy is as sustainable and responsible as possible.
Balancing the growth of solar power with careful land management and sustainable manufacturing is a key goal for the energy sector.

201. (C) Infrared
When considering the total solar irradiance reaching the Earth, the infrared portion of the spectrum contains more than half of the total energy. Infrared radiation consists of longer wavelengths that are primarily responsible for the heating effect of sunlight on the atmosphere and surface. While visible light is more easily detected by the human eye, it carries less of the total energy flux from the sun. Understanding the distribution of energy across these bands is essential for studying the global energy balance and designing efficient solar thermal systems.
The high energy content of the infrared band is what makes it the primary driver of the Earth's thermal and climate systems.

202. (C) Its calorific value and ash content
The grading of coal is based on its physico-chemical characteristics, with the calorific value and ash content being the most important factors. The calorific value determines the energy content of the coal, while the ash content indicates the amount of non-combustible material that will be left after burning. High-quality coal has a high calorific value and low ash content, making it more efficient and valuable for industrial use. These characteristics are essential for the

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of carbon dioxide, primarily due to its massive industrial sector and reliance on coal. As China continues to grow and urbanize, its energy demand has increased significantly, making it a central player in global energy markets and climate negotiations. While China is also a leader in renewable energy investment, its current emissions reflect the scale of its industrial base. China's transition to a low-carbon economy is critical for meeting international climate goals.

China's national energy policies and its commitment to carbon neutrality are essential for the future of the global climate system.

169. (B) Its availability is intermittent and not constant.

A primary disadvantage of wind power is its intermittency, as electricity is only generated when the wind is blowing within a certain speed range. Because wind speeds are not constant and can change rapidly, the power output of a wind farm can vary significantly. This requires the use of energy storage or backup power sources to ensure a reliable supply of electricity to the grid. Managing this variability is a major technical challenge for integrating large amounts of wind energy into modern power systems.

Advances in weather forecasting and energy storage technology are helping to overcome the challenges of wind energy intermittency today.

170. (A) (i), (ii), (iii)

The hydrogen-to-carbon ratio is a measure of the chemical composition of different fossil fuels. Coal, being a solid carbon-rich material, has the lowest ratio, while petroleum, a liquid hydrocarbon mixture, has a higher ratio. Natural gas, which consists primarily of methane (CH4), has the highest hydrogen-to-carbon ratio of all fossil fuels. This ratio is important because fuels with more hydrogen release less carbon dioxide per unit of energy burned, making natural gas the cleanest-burning of the three primary fossil fuels used today.

Understanding the chemical makeup of fossil fuels is essential for evaluating their energy efficiency and environmental impact in different applications.

171. (B) The decay of radioactive elements and residual heat within the Earth's core.

Geothermal energy is the heat stored within the Earth, originating from the natural decay of radioactive isotopes like uranium and potassium, as well as the residual heat from the planet's formation. This internal heat flows toward the surface and can be harnessed for power generation and heating. Unlike solar or wind energy, geothermal is a continuous and reliable resource that is independent of atmospheric conditions. It provides a constant supply of energy that can be used to provide baseload electricity for the grid.

Tapping into the Earth's internal heat is an important part of developing a diverse and sustainable renewable energy portfolio globally.

172. (A) (a) and (c)

Nuclear fuels are materials that can sustain a fission reaction, such as uranium-235, which is a fissile isotope. In contrast, uranium-238 is fertile, meaning it can absorb a neutron to eventually become fissile plutonium-239. Natural uranium consists almost entirely of uranium-238, with only a tiny fraction of uranium-235. Understanding these different roles is fundamental for managing nuclear fuel cycles and designing efficient reactors. These nuclear materials are the source of concentrated energy that powers commercial nuclear facilities around the world today.

The careful management of fissile and fertile materials is essential for the safe and efficient operation of nuclear power systems.

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173. (A) To collect and store solar thermal energy at low cost.

The primary purpose of a solar pond is to capture and store solar radiation as heat for long periods. By using a salinity gradient to prevent convection, the pond traps thermal energy in its lower, denser layers, creating a stable heat reservoir. This stored energy can then be used for low-temperature applications like space heating, desalination, or power generation. Solar ponds provide an integrated and cost-effective way to utilize solar energy, especially in areas with suitable land and climate conditions for their operation.

This technology offers a unique solution for large-scale solar thermal storage and sustainable energy use in various industries globally.

174. (A) Developed countries generally have higher per capita emissions.

of renewable technologies. While fossil fuels still dominate the total energy mix, the rapid growth of renewables is transforming the electricity sector and providing a pathway to a more sustainable and low-carbon future. This change is essential for meeting international climate and environmental goals.
The continued expansion of renewable energy is a major component of global efforts to build a more sustainable energy system.

209. (A) The use of hazardous materials in their manufacturing and disposal challenges.
While solar energy is clean during its operation, the lifecycle of photovoltaic panels presents environmental challenges related to the materials used in their production and their eventual disposal. The manufacturing process often involves hazardous chemicals and requires significant energy. Additionally, at the end of their useful life, the panels must be properly recycled or disposed of to prevent environmental contamination from materials like lead or cadmium. Addressing these issues through better design and recycling programs is essential for ensuring that solar energy is a truly sustainable technology.
Developing sustainable manufacturing and recycling systems is a key focus for the continued growth of the solar energy industry.

210. (C) Natural gas is a major cause of ozone layer depletion.
Natural gas is a fossil fuel primarily composed of methane, and while its use contributes to global warming through carbon dioxide emissions, it is not a major cause of ozone layer depletion. Ozone depletion is primarily caused by specific human-made chemicals like chlorofluorocarbons that contain chlorine or bromine. Understanding the distinct environmental impacts of different energy sources is essential for developing effective environmental policies. Natural gas is considered a relatively clean-burning fossil fuel, but its climate impact still requires careful management as part of sustainable energy planning.
Correctly identifying the environmental impacts of different fuels is fundamental to the study of energy and the global environment today.

211. (B) To keep the water in the primary loop from boiling.
In a Pressurized Water Reactor, the water in the primary loop is kept under very high pressure to prevent it from boiling, even though it reaches extremely high temperatures. This allows the water to remain in a liquid state as it transfers heat from the reactor core to a secondary loop, where steam is then produced to drive a turbine. Maintaining this high pressure is a critical part of the reactor design and ensures the efficient and safe transfer of heat for electricity generation from nuclear energy.
The use of high pressure is a defining feature of PWR technology and is essential for its reliable and safe operation.

212. (A) The concentration of CO_2 in the atmosphere has been increasing since the industrial revolution.
Since the beginning of the industrial revolution, the extensive burning of fossil fuels has led to a steady and significant increase in the concentration of carbon dioxide in the atmosphere. This rising concentration has enhanced the natural greenhouse effect, leading to the phenomenon of global warming and broader climate change. While individual countries have different emission levels and historical responsibilities, the overall trend of increasing CO_2 is a clear and well-documented global environmental change that requires urgent international action to mitigate its long-term impacts on the planet.
Reducing global CO_2 emissions is the most critical challenge for achieving long-term environmental sustainability and protecting the climate system.

213. (B) Induced seismicity due to the weight of the water in the reservoir.
Large-scale hydropower projects can sometimes lead to induced seismicity, where the weight and pressure of the water in the reservoir trigger small earthquakes or seismic activity in the surrounding region. This is a recognized geomechanical effect that must be carefully assessed during the planning and monitoring of massive dam projects. While these events are usually minor, they represent one of the environmental and geological considerations associated with the development of large-scale water storage systems for renewable energy production in various parts of the world today.

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and sustainable choice for electricity generation globally.

248. (B) The burning of fossil fuels
The primary driver of the significant increase in atmospheric carbon dioxide concentrations over the past two centuries is the extensive burning of fossil fuels like coal, oil, and natural gas. This human activity has released billions of tons of carbon that was stored for millions of years into the climate system, leading to an enhanced greenhouse effect and global warming. While other factors like deforestation also contribute, fossil fuel combustion remains the largest source of human-caused CO_2 emissions and is the main target for global climate change mitigation.
Reducing the reliance on fossil fuels is the most critical step for lowering global greenhouse gas emissions and protecting the climate.

249. (A) Visual and aesthetic impact on the landscape.
A major environmental and social impact associated with large-scale wind energy is its effect on the visual and aesthetic quality of the landscape. The massive turbines and associated infrastructure can significantly change the appearance of rural and coastal areas, leading to concerns from local communities. While wind power is a clean and renewable resource, managing these visual impacts is an important part of the planning and public engagement process. Careful siting and design of wind farms are used to minimize these effects and improve the social acceptance of wind energy.
Balancing the need for renewable power with the preservation of scenic and natural landscapes is a key part of sustainable energy development.

250. (A) All of the above.
The difference in energy use patterns between developed and developing countries is reflected in their per capita and total energy consumption, as well as the specific mix of energy sources they utilize. Developed countries typically have higher per capita consumption and established infrastructures, while developing countries have growing total demand and a different set of industrial priorities. Understanding these diverse patterns is essential for the effective planning and development of both national and international energy and climate policies that promote sustainable growth and environmental protection.
Addressing these differences in energy patterns is vital for achieving global energy security and meeting international environmental and climate goals.

251. (B) Solar radiation is composed of UV, visible, and IR wavelengths, with peak intensity in the visible spectrum.
Solar radiation consists of a broad spectrum of electromagnetic waves, primarily categorized into ultraviolet, visible, and infrared components. The distribution of energy across these wavelengths is non-uniform, with the peak intensity occurring specifically within the visible light range. This spectral composition is fundamental to Earth's climate and vital biological processes such as photosynthesis.

252. (A) To modify the radiation by absorbing and scattering specific wavelengths.
Earth's atmosphere acts as a complex filter that significantly modifies incoming solar radiation before it reaches the surface. It performs critical functions by absorbing and scattering specific wavelengths of energy. For instance, the ozone layer targets ultraviolet radiation, while various atmospheric gases absorb infrared energy, thereby regulating the planet's temperature and protecting life.

253. (C) Developing more effective solar energy capture devices.
Developing and optimizing solar energy capture devices requires a precise understanding of the sun's spectral characteristics. Different technological designs are engineered to target and efficiently harness specific portions of the electromagnetic spectrum, such as visible or infrared light. This scientific knowledge ensures that energy conversion systems are matched to the available solar energy distribution for maximum efficiency.

254. (D) The ozone layer
The stratospheric ozone layer serves as a protective shield for the planet by absorbing a substantial fraction of incoming ultraviolet radiation from the sun. This process prevents high-energy radiation from reaching the surface in harmful quantities. While other atmospheric

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High calorific values mean more energy is available for a given amount of fuel, making it more efficient for use.
This parameter is essential for fuel selection in industrial processes, power generation, and the transportation sector globally today.

220. (A) (a), (b), (c), (d)
Various energy technologies operate based on distinct physical and natural principles. Solar collectors capture thermal energy, while photovoltaic modules generate electricity directly from light. A solar pond utilizes a salinity gradient to trap and store heat, and a tidal barrage harnesses the potential energy created by the rise and fall of tides. Correctly identifying these principles is fundamental for understanding how different renewable resources are harnessed to provide sustainable and reliable power for modern society across a range of different environmental and geographic conditions.
Accurate knowledge of these principles is essential for the effective design and integration of diverse renewable energy systems worldwide.

221. (A) P-4, Q-1, R-2, S-3
Different energy sources and technologies are associated with specific technical terms and components. Shale oil is obtained from the solid kerogen found in rock, while nuclear energy is produced through the process of fission. Wind power utilizes large turbine blades to capture the kinetic energy of the air, and bioenergy can be produced through the anaerobic digestion of organic matter. Understanding these relationships is fundamental to the study of modern energy systems and the principles that govern their operation and environmental impact globally today.
Correctly identifying these terms helps in the clear communication and analysis of diverse energy technologies and their roles in society.

222. (C) Slow down fast neutrons to thermal energies.
In a thermal nuclear reactor, the neutrons released by fission are moving too fast to be easily absorbed by other uranium-235 nuclei to cause further fission. The role of the moderator is to surround the fuel and slow these neutrons down to thermal speeds, which significantly increases the probability of sustaining a controlled chain reaction. This process is essential for the efficient and stable operation of the reactor. Common moderators include water and graphite, depending on the specific reactor design and technology used.
The use of a moderator is a key feature of modern nuclear power plants and is vital for their safe operation.

223. (B) Natural and anthropogenic drivers of climate change.
Radiative forcing is a scientific concept used to measure how various factors, both natural and human-caused, alter the Earth's energy balance. It quantifies the change in the net irradiance at the tropopause, with positive forcing leading to warming and negative forcing leading to cooling. By analyzing these forcings from greenhouse gases, aerosols, and solar changes, scientists can identify the primary drivers of global climate change. This concept is central to understanding the human impact on the climate and for predicting future temperature trends.
Monitoring and reducing positive radiative forcing is the main goal of international efforts to mitigate global warming and protect the environment.

224. (D) All of the above.
The energy use pattern of a country is deeply connected to its level of economic development and industrialization. Highly industrialized countries exhibit much higher per capita energy consumption and total energy demand compared to less industrialized ones. They also use a different mix of energy sources, with more focus on industrial and transport fuels. As countries develop and their economies grow, their energy needs and patterns of use change significantly, presenting both challenges and opportunities for sustainable and efficient energy planning on a national and global scale.
Understanding these diverse energy patterns is essential for developing effective policies to promote energy access and environmental sustainability worldwide.

225. (B) Disruption to aquatic and terrestrial ecosystems.
The development of large-scale hydropower projects involves the construction of massive dams, which significantly alter the natural flow of rivers and flood large areas of land. This process

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Understanding and managing the geological impacts of large reservoirs is a key part of ensuring the safety and sustainability of hydropower.

214. (A) (ii), (iv), (i), (iii)
The formation of coal follows a logical geological sequence over millions of years. First, plant matter accumulates in a swampy environment where it is protected from complete decay. This material slowly transforms into peat, which is then buried and compacted under layers of sediment. Over time, the increasing heat and pressure from the overlying rocks cause chemical and physical changes, eventually producing different ranks of coal. This process, known as coalification, is how ancient solar energy is concentrated and stored in a solid fossil fuel source.
Understanding the geological history of coal is essential for its discovery, mining, and use as a primary global energy resource.

215. (A) Natural gas is primarily methane, while petroleum is a mix of longer-chain hydrocarbons. While both are fossil fuels, natural gas and petroleum differ significantly in their chemical composition and physical state. Natural gas is primarily composed of methane, the simplest hydrocarbon, and exists in a gaseous state. In contrast, petroleum is a complex liquid mixture of many different and often longer-chain hydrocarbons. These differences are a result of the specific geological conditions and organic materials that formed them. They also determine how each fuel is extracted, transported, and refined into various energy products for use in the global economy.
Recognizing the distinct compositions of these fuels is fundamental for their industrial processing and for evaluating their environmental impact in use.

216. (B) Production of radioactive waste.
The combustion of fossil fuels involves the chemical reaction of hydrocarbons with oxygen, which releases heat energy, carbon dioxide, and other gases like sulfur and nitrogen oxides. However, this process does not produce radioactive waste, which is a unique byproduct of nuclear energy generation. Distinguishing between the environmental impacts of chemical combustion and nuclear fission is essential for understanding the different challenges and risks associated with each energy source. While fossil fuels are major contributors to global warming, their pollution is fundamentally chemical in nature.
Understanding the distinct pollution profiles of different energy sources is a key part of modern environmental science and sustainable planning.

217. (A) Both A and R are true and R is the correct explanation of A.
Wind turbines are generally more efficient at higher altitudes because wind speeds are typically higher and more consistent as you move away from the Earth's surface. The ground creates friction and obstacles that slow the wind and cause turbulence in the lower layers of the atmosphere. By placing turbines on tall towers or at higher elevations, they can capture the more powerful and steady winds, significantly increasing their potential for electricity generation. This physical relationship is a primary consideration in the design and siting of modern wind farms.
Maximizing energy capture through the use of taller turbines is a key strategy for improving the economic viability of wind power.

218. (C) Helium nuclei
The Sun's immense energy is generated by the process of nuclear fusion, where hydrogen nuclei are forced together under extreme temperatures and pressures to form helium nuclei. This reaction releases an enormous amount of energy in the form of radiation, which eventually reaches the Earth and sustains all life. Fusion is the most efficient known way to release energy from matter and is the fundamental power source of the stars. Understanding this process is central to both solar physics and the development of sustainable fusion energy.
Fusion technology aims to replicate this solar process on Earth to provide a safe and nearly limitless source of clean power.

219. (B) Energy content
The calorific value of a fuel is a technical term that represents its total energy content, which is the amount of heat released during its complete combustion. This value is a fundamental property used to compare the efficiency and economic value of different fuels. It is typically expressed in units of energy per unit of mass or volume and is measured in a laboratory using a calorimeter.

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International efforts to combat climate change focus on reducing the carbon footprint of the global energy and industrial sectors.

231. (A) Its intermittent nature and land requirements.
The large-scale exploitation of solar energy requires careful consideration of its intermittent nature, as power is only generated when the sun is shining. This necessitates the use of energy storage or other power sources to ensure a reliable supply. Additionally, utility-scale solar farms require significant land area, which can lead to conflicts over land use and potential impacts on local ecosystems. Managing these technical and environmental factors is an important part of the planning and development process for sustainable and effective solar power systems globally.
Developing cost-effective energy storage and efficient land-use strategies is essential for the continued growth of large-scale solar power today.

232. (A) (a), (b), and (c)
Fossil fuels like coal, petroleum, and natural gas were formed over millions of years from organic matter and release concentrated energy when burned. However, because they take so long to form, their global reserves are finite and they are considered non-renewable on a human timescale. Once these resources are extracted and consumed, they cannot be replaced within any reasonable period. Understanding the nature and limits of fossil fuel resources is fundamental for developing sustainable energy policies and for transitioning to a more resilient and renewable energy future.
The finiteness of fossil fuels is a key driver for the global shift toward cleaner and more sustainable energy technologies.

233. (A) Heat produced by the complete combustion of a unit quantity of the fuel.
The calorific value of a fuel is a technical measure of the total amount of heat energy released during its complete combustion under standardized conditions. This value is used to compare the efficiency and economic worth of different fuels and is typically expressed per unit of mass or volume. High calorific values indicate that a fuel provides more energy for a given quantity, making it more efficient for use in industrial processes and power generation. This parameter is essential for fuel selection and energy management worldwide.
Accurate measurement of calorific values ensures fair trade and the efficient design of various thermal and power systems today.

234. (B) Boil a working fluid with a low boiling point, which then drives a turbine.
OTEC technology generates electricity by utilizing the thermal gradient between the warm surface and cold deep waters of the ocean. This temperature difference is used to boil a working fluid, such as ammonia, which has a very low boiling point. The resulting vapor expands and drives a turbine to produce power. The vapor is then condensed back into a liquid using the cold deep water, and the cycle continues. This process provides a reliable and continuous source of renewable energy from the ocean's vast thermal reservoir.
OTEC represents a unique opportunity for sustainable power generation, especially for tropical and subtropical coastal and island nations.

235. (C) Nuclear fission.
The fundamental principle of a nuclear reactor is to maintain and control the rate of nuclear fission, where heavy atomic nuclei are split to release energy. This process is initiated and regulated to provide a steady supply of heat, which is then used to generate steam for electricity production. By using control rods and other safety systems, operators ensure that the fission chain reaction remains stable and safe. This technology provides a concentrated and low-carbon source of energy that plays a major role in the global electricity mix.
The precise control of nuclear fission is essential for the safe and efficient operation of commercial nuclear power plants worldwide.

236. (B) Both A and R are true but R is not the correct explanation of A.
Gas hydrates represent a potentially enormous source of natural gas, but their development is complicated by significant technical and environmental challenges. They are only stable under high pressure and low temperature, so any extraction attempt could lead to the uncontrolled release of methane, a potent greenhouse gas.

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While their potential as an energy source is clear, these risks and difficulties are separate from the scientific definition of what they are. Developing safe and effective extraction methods is the primary focus of research into utilizing this unconventional energy resource.

Managing the environmental and technical risks of gas hydrates is a major challenge for the future of the energy industry.

237. (C) Gasification

Gasification is a thermochemical process used to produce energy from biomass by heating it in a controlled environment to create a combustible gas called syngas. This gas can be used for heating, generating electricity, or as a chemical feedstock. Gasification is more efficient and cleaner than direct combustion and allows for the use of a wide range of biomass feedstocks. This technology is a key component of modern efforts to develop versatile and sustainable energy systems from renewable organic materials and waste products. Expanding the use of biomass gasification helps in providing local and sustainable power while reducing the reliance on fossil fuels.

238. (A) Level of economic development and industrialization.

A country's energy use pattern is most directly determined by its level of economic development and the scale of its industrial and infrastructure systems. Highly developed nations typically have much higher per capita energy consumption due to energy-intensive lifestyles and advanced industries. As developing nations grow and industrialize, their energy needs and patterns of use also change, reflecting their increasing economic activity and urban expansion. Understanding these socio-economic drivers is essential for the effective planning and development of national and international energy and climate policies.

Promoting sustainable and efficient energy use is a key goal for all nations as they work to balance development with environmental protection.

239. (A) Significantly lower

When compared on a per capita basis, the carbon dioxide emissions in India are significantly lower than those of highly developed nations. This reflects the different levels of industrialization, infrastructure, and standards of living between the regions. While India's total emissions are rising due to its large population and economic growth, the individual impact remains relatively small on a global scale. This distinction is a central theme in international climate discussions regarding the equitable responsibility for reducing greenhouse gas emissions and achieving global environmental goals.

Achieving sustainable development while maintaining low per capita emissions is a major focus for India's national energy and environmental policies.

240. (D) Nuclear

The large-scale use of nuclear energy involves the handling and processing of radioactive materials, which presents a risk of contamination if not managed properly. This includes the management of spent fuel and other radioactive wastes produced during the fission process. While nuclear power plants are designed with multiple safety systems to prevent leaks, the potential for accidental release of radioactivity is a major environmental and safety concern. Ensuring the safe containment and disposal of these materials is the primary focus of the nuclear industry and its regulatory bodies worldwide.

Stringent safety standards and robust waste management are essential for protecting the environment and public health from nuclear-related risks.

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241. (C) Ultraviolet-C (UVC)

The ozone layer in the stratosphere plays a critical role in protecting life on Earth by absorbing almost all of the Sun's high-energy Ultraviolet-C radiation. This part of the spectrum is the most harmful to biological organisms, and its absorption prevents it from reaching the surface. The ozone layer also absorbs a significant portion of UVB radiation. Understanding the role of the atmosphere in filtering solar radiation is fundamental for both environmental science and for studying the health impacts of changes in the ozone layer.

Protecting the ozone layer is an international environmental priority to ensure the safety of the planet from harmful solar radiation.

242. (A) Coal < Petroleum < Natural Gas

Different fossil fuels have varying energy contents per unit of mass, which is a measure of their

specific energy. Coal generally has the lowest energy density among the three primary fossil fuels, while petroleum has a higher density as a concentrated liquid. Natural gas, being a simple hydrocarbon, has the highest energy content per kilogram. This ranking is important for evaluating the efficiency of these fuels for transportation and power generation and for understanding their relative economic and environmental value in the global energy market today.

The high specific energy of natural gas and petroleum is one reason for their widespread use in the global economy.

243. (B) Vaporization of water

The net calorific value is lower than the gross calorific value because it does not include the latent heat that would be released if the water vapor formed during combustion was condensed. In most practical heating and power systems, the hot exhaust gases are released into the atmosphere, so this heat is lost. The water comes from both the moisture in the fuel and the combustion of the fuel's hydrogen content. Recognizing this difference is essential for the accurate thermal design and analysis of combustion-based energy systems in real-world applications.

Engineers use net calorific values to provide a realistic assessment of the fuel efficiency and performance of thermal power plants.

244. (A) Turn turbines.

Tidal power generation harnesses the energy of moving ocean water by using it to spin turbines. This can be done by capturing the kinetic energy of tidal currents or by building barrages that use the rise and fall of the tide to create a difference in water height, which then drives the turbines. This mechanical energy is then converted into electricity by a generator. Tidal energy is a clean and highly predictable renewable resource, as the tidal cycles are determined by consistent astronomical forces of the moon and sun.

The predictable nature of tidal energy makes it a valuable addition to a diverse and sustainable renewable energy mix globally today.

245. (A) P-2, Q-1, R-4, S-3

Every renewable energy technology operates based on a specific physical principle. Solar photovoltaic systems use the conversion of light into electricity through the photoelectric effect, while geothermal energy harnesses the heat from within the Earth. Hydropower utilizes the gravitational potential energy of water stored at a height, and OTEC generates power by utilizing the temperature difference between ocean layers. Understanding these underlying principles is fundamental for designing and implementing diverse renewable energy systems to meet the global demand for sustainable and low-carbon power.

Accurate knowledge of energy principles is essential for the effective integration and management of diverse renewable energy resources worldwide.

246. (B) (a), (b), (d), and (e)

Nuclear energy can be released through either the splitting of heavy nuclei, known as fission, or the joining of light nuclei, known as fusion. Both processes release immense amounts of energy and convert mass into heat. Fission is the principle used in all current commercial power plants and produces radioactive waste as a byproduct. Fusion, while releasing more energy per nucleon, is not yet a commercial technology. Correctly identifying these principles is fundamental for understanding the different types of nuclear power and their environmental and safety implications.

Understanding the physical laws governing nuclear energy is essential for its safe and sustainable development as a low-carbon power source.

247. (A) Photovoltaic modules

Photovoltaic modules are specialized devices that achieve the direct conversion of solar energy into electricity using semiconductor materials. When sunlight strikes the solar cells, it releases electrons through the photoelectric effect, creating a flow of electric current. Unlike solar collectors that produce heat, PV modules provide a clean and silent source of electrical power without any moving parts. This technology is a major component of the global transition to renewable energy and is used for everything from small-scale residential systems to large utility-scale solar power plants.

The continued advancement in PV technology is making solar energy a increasingly affordable

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leads to habitat loss and can disrupt the migration and breeding patterns of aquatic and terrestrial species. While hydropower is a low-carbon and renewable source of electricity, these ecological impacts are a major environmental trade-off that must be carefully managed. Sustainable hydro development focuses on minimizing these disruptions through better site selection and management of the river system.

Balancing the need for renewable energy with the protection of biodiversity is a key challenge for sustainable hydropower planning globally.

226. (D) Biomass

Fossil fuels are non-renewable energy sources like coal, petroleum, and natural gas that were formed over millions of years from ancient organic matter. Biomass, however, consists of recently living organic materials like wood and agricultural waste, which can be replenished on a human timescale. While biomass is also an organic energy source, its renewable nature and contemporary origin distinguish it from the finite fossil fuel reserves found deep within the Earth. Understanding this distinction is fundamental to the study of sustainable energy and the transition to a low-carbon economy.

The shift from finite fossil fuels to renewable biomass and other clean energy sources is a major global environmental goal.

227. (A) Hardness, density, moisture content, and chemical composition.

The physico-chemical characteristics of coal include both its physical properties and its chemical makeup. Attributes such as hardness and density are important for handling and processing, while moisture content and chemical composition determine the coal's energy value and how it will burn. These characteristics are essential for the commercial grading and industrial use of coal, as they affect the efficiency of combustion and the nature of the resulting emissions. Analyzing these properties allows for more effective and responsible management of coal as an energy resource.

Detailed knowledge of coal's properties is vital for its industrial application and for minimizing its overall environmental impact.

228. (A) The kinetic energy of the moving air.

Wind power generation is based on harnessing the kinetic energy of moving air masses. When the wind flows over the blades of a turbine, it causes them to spin, converting the air's motion into mechanical energy. This mechanical energy is then used to drive a generator that produces electricity. The amount of power generated depends directly on the wind speed and the design of the turbine blades. Wind is a clean and renewable resource that provides a major contribution to the global supply of sustainable and low-carbon electricity.

Promoting wind energy development is a key strategy for reducing greenhouse gas emissions and improving global energy security today.

229. (B) In a BWR, steam is generated directly inside the reactor vessel.

A primary difference between these two common nuclear reactor designs is where the steam is produced. In a Boiling Water Reactor, the water is allowed to boil directly in the reactor core to create steam for the turbine. In contrast, a Pressurized Water Reactor keeps the primary water under high pressure to prevent boiling and uses a separate steam generator to produce steam in a secondary loop. Understanding these different technologies is essential for the design, operation, and safety management of commercial nuclear power facilities around the world.

Each reactor type has its own unique engineering features and safety systems for reliable and efficient electricity generation today.

230. (B) An increase in atmospheric greenhouse gas concentrations.

A major environmental implication of using fossil fuels is the release of carbon dioxide and other greenhouse gases into the atmosphere. These gases trap heat within the Earth's climate system, leading to an enhanced greenhouse effect and global warming. This process is the primary driver of modern climate change and its associated impacts on sea levels and weather patterns. Reducing the reliance on fossil fuels and transitioning to cleaner energy sources is the most important step for lowering greenhouse gas concentrations and protecting the global environment for the future.

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components like water vapor and carbon dioxide interact with infrared energy, ozone specifically targets the ultraviolet spectrum.

255. (C) drives the process of photosynthesis.
A significant portion of the sun's energy output is concentrated within the visible light spectrum, where the peak intensity of solar radiation occurs. This specific range of wavelengths is biologically crucial because it facilitates the process of photosynthesis in plants. Photosynthesis forms the foundation of most food chains on Earth, making this spectral concentration vital for life.

256. (B) The degree of metamorphism or rank.
Coal classification is fundamentally determined by the degree of metamorphism it has experienced over geological time, a property referred to as rank. This rank serves as a primary indicator of the fuel's essential characteristics, including its carbon concentration, moisture content, and energy value. Higher degrees of geological heating and pressure result in coal types with superior quality.

257. (D) Lignite, Sub-bituminous, Bituminous, Anthracite
Coal ranks follow a specific progression based on their carbon content and energy output. This sequence begins with lignite, which has the lowest energy value and highest moisture. It advances through sub-bituminous and bituminous ranks as the carbon concentration increases. Finally, anthracite represents the highest rank, possessing the most superior energy density and carbon levels among all types.

258. (A) the presence of impurities such as sulfur and ash.
The environmental consequences of burning coal are heavily influenced by the presence of internal impurities like sulfur and ash. These components determine the level of pollutants released during combustion and affect overall efficiency. Understanding the specific chemical composition of coal is therefore a decisive factor in energy planning and implementing effective pollution control measures for various industries.

259. (C) It is abundant and has a high energy content.
Bituminous coal is extensively utilized for large-scale electricity generation and industrial steel production because it offers a high energy content. Furthermore, its relative abundance makes it a practical choice for meeting global energy demands. This combination of high caloric output and widespread availability allows for efficient and cost-effective power plant operations across many regions worldwide.

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260. (A) As rank increases, moisture content decreases and energy content increases.
As coal undergoes more intense metamorphism and increases in rank, its physical and chemical properties change significantly. The carbon concentration and overall energy value progressively rise, while the moisture content simultaneously decreases. This direct correlation means that higher-rank coals, like anthracite, are much more energy-dense and contain far less water than lower-rank coals such as lignite.

261. (D) the decomposition of marine microorganisms.
Petroleum and natural gas originate from the anaerobic decomposition of marine microorganisms that lived millions of years ago. These organic remains were buried under layers of sediment and subjected to intense heat and pressure over vast geological epochs. This slow transformation process eventually resulted in the complex mixtures of hydrocarbons found today in various subterranean reservoirs across the globe.

262. (B) fractional distillation.
Fractional distillation is the primary industrial process used within refineries to separate crude oil into its various constituent parts. This method exploits the different boiling points of the hydrocarbons present in the mixture. By heating the oil, components such as gasoline, diesel, and kerosene are isolated as they vaporize and condense at specific temperature ranges within the column.

263. (C) It produces fewer pollutants and less CO_2 upon combustion.
Natural gas is characterized as a cleaner fossil fuel because its combustion releases significantly fewer pollutants compared to coal or petroleum. It produces a lower volume of carbon dioxide per unit of energy generated. Primarily composed of methane, it burns more efficiently and leaves behind fewer residues, making it a preferred

option for reducing immediate environmental footprints.

264. (D) Its viscosity and density.
Viscosity and density are the essential physico-chemical characteristics used to classify and differentiate various types of crude oil from around the world. Density is frequently expressed as API gravity, which helps determine the oil's quality and market value. These physical properties are critical for determining the ease of extraction, transportation requirements, and the specific refining processes needed.

265. (A) Methane
Natural gas is predominantly composed of methane, a simple hydrocarbon with the chemical formula CH4. While it may contain smaller amounts of other light hydrocarbons like ethane, propane, and butane, methane remains the principal component. This high methane concentration accounts for the fuel's specific energy properties and its relatively clean combustion profile compared to heavier fossil fuel sources.

266. (B) Kerogen
Kerogen is the solid organic matter found embedded within shale rock formations that serves as the precursor to shale oil. Through a specialized industrial process called pyrolysis, this material is heated to extremely high temperatures in the absence of oxygen. This thermal treatment converts the kerogen into a synthetic form of crude oil that can then be refined.

267. (B) Pumping out water to reduce pressure in the coal seam.
The extraction of methane from coal seams involves a process of dewatering to release the adsorbed gas. By drilling into the seam and pumping out groundwater, the hydrostatic pressure within the coal matrix is reduced. This pressure drop facilitates the desorption of methane molecules from the internal surfaces of the coal, allowing the gas to be captured effectively.

268. (A) water molecules.
Gas hydrates, also known as clathrates, are unique crystalline structures where gas molecules are physically trapped within a lattice of water molecules. Predominantly containing methane, these ice-like solids form under specific conditions of high pressure and low temperature. They are most commonly found in deep oceanic sediments and in permafrost regions, representing a vast but challenging energy resource.

269. (C) 'tight oil' extracted via hydraulic fracturing.
A clear distinction exists between shale oil, which is produced by the thermal conversion of kerogen through pyrolysis, and tight oil. Tight oil refers to liquid crude oil that is trapped in low-permeability shale formations and is typically extracted using hydraulic fracturing techniques. Understanding these different unconventional resources is essential for identifying the appropriate extraction technologies and economic viability.

270. (D) Potential for methane release and seabed instability.
The extraction of gas hydrates carries significant environmental risks, primarily involving the potential for large-scale methane release into the atmosphere. Because methane is a potent greenhouse gas, such leaks could accelerate global warming. Additionally, disturbing these crystalline structures can compromise the stability of the seabed, potentially leading to underwater landslides and other geological hazards in deep-sea environments.

271. (C) GCV accounts for the latent heat of vaporization of water, while NCV does not.
The fundamental distinction between Gross Calorific Value and Net Calorific Value lies in the treatment of the latent heat of vaporization. Gross Calorific Value includes the heat energy contained in the water vapor produced during combustion. Conversely, Net Calorific Value excludes this latent heat, as it is typically lost as steam in real-world applications like engines and boilers.

272. (B) the usable heat energy available in most practical combustion systems.
Net Calorific Value signifies the actual usable heat energy available in the majority of practical combustion systems. This measurement reflects real-world conditions where the water vapor generated during the burning process is not condensed and is instead expelled as steam. Consequently, it provides a more accurate

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assessment of a fuel's performance in engines, furnaces, and industrial power boilers.

273. (D) A fuel with a high hydrogen content.
The discrepancy between Gross and Net Calorific Values is most pronounced in fuels that possess a high hydrogen content. During combustion, hydrogen atoms combine with oxygen to form water vapor. Because the Gross value includes the latent heat of this water while the Net value does not, the gap between these two measurements increases with the amount of water produced.

274. (A) both the fuel's hydrogen content and its inherent moisture.
The water vapor produced during the combustion of a fuel originates from two primary sources: the fuel's internal hydrogen content and any moisture already present. When hydrogen undergoes chemical reactions with oxygen, it forms water, releasing latent heat that is captured in the Gross Calorific Value. Both factors contribute to the total amount of steam generated during the process.

275. (C) Because it includes the heat energy contained in the water vapor, making it a larger value than NCV.
Gross Calorific Value is designated as the higher heating value because it represents the total heat released during complete combustion, including the latent heat of vaporization. Since it accounts for the energy stored in water vapor that is usually lost in practical systems, its numerical value is always higher than the Net Calorific Value, which excludes that specific heat component.

276. (A) Converting potential energy to kinetic energy to electrical energy.
Hydropower generation is based on a specific sequence of energy transformations starting with gravitational potential energy. Water stored at a height in a reservoir is released to flow downwards, converting its potential energy into kinetic energy. This moving water then drives turbines, which convert mechanical energy into electrical energy through generators, providing a renewable source of power.

277. (D) a barrage captures potential energy, while a stream generator captures kinetic energy.
Tidal barrages and tidal stream generators utilize different physical principles to harness ocean energy. A barrage functions like a dam, capturing the potential energy of water held at different levels during tidal cycles. In contrast, tidal stream generators operate like underwater wind turbines, directly capturing the kinetic energy of moving water currents as the tides flow in and out.

278. (B) A substantial temperature difference between surface and deep ocean water.
The viability of Ocean Thermal Energy Conversion systems depends entirely on the existence of a substantial temperature gradient between the ocean's surface and its depths. Warm surface water is used to vaporize a working fluid, while cold water from deeper layers is used for condensation. This process requires a stable and significant temperature difference, typically found in tropical maritime regions.

279. (C) To be vaporized to drive a turbine and then condensed to repeat the cycle.
In a closed-cycle Ocean Thermal Energy Conversion system, the working fluid, such as ammonia, serves as the medium for energy transfer. The fluid is vaporized by the heat from warm surface seawater, creating pressure to drive a power turbine. Afterward, it is condensed back into a liquid state using cold deep-sea water, allowing the continuous cycle to repeat.

280. (D) Underwater wind turbines
Tidal stream generators are frequently compared to underwater wind turbines because they share a similar mechanical operating principle. Both technologies utilize large rotor blades to capture the kinetic energy of a moving fluid. While wind turbines harness the flow of air in the atmosphere, tidal stream generators are submerged to capture the predictable and powerful flow of ocean currents.

281. (A) Kinetic energy to mechanical energy.
A wind turbine operates by capturing the kinetic energy of moving air and transforming it into mechanical energy through the rotation of its blades. This rotational force is then transferred to an internal generator, which converts the mechanical energy into electricity. This sequence

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R. Centrifugal Collector
S. Fabric Filter
List II: (Working Principle)
1. Gravitational force
2. Inertial and centrifugal forces
3. Sieving, impaction, and diffusion
4. Electrical forces
(A) P-4, Q-1, R-2, S-3
(B) P-3, Q-2, R-1, S-4
(C) P-4, Q-3, R-2, S-1
(D) P-1, Q-4, R-3, S-2

11. The Gaussian plume model is most appropriately used for predicting pollutant concentration from:
(A) A large number of small, scattered sources in a city.
(B) A long line of traffic on a highway.
(C) Natural sources like volcanoes.
(D) A continuous point source, like a smokestack.

12. In the context of gaseous pollutant control, what is the process where a gas or vapor is collected on the surface of a solid?
(A) Absorption
(B) Adsorption
(C) Condensation
(D) Combustion

13. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The mixing depth in the atmosphere is typically higher during the day than at night.
Reason (R) : Solar heating of the Earth's surface during the day creates unstable atmospheric conditions and promotes vertical mixing.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

14. Which of the following is NOT a primary method for controlling gaseous pollutants?
(A) Absorption
(B) Catalytic combustion
(C) Condensation
(D) Fabric filtration

15. Consider the following statements regarding the impact of air pollutants:
(a) Sulphur dioxide primarily affects the respiratory system.
(b) Carbon monoxide binds to hemoglobin, reducing the oxygen-carrying capacity of blood.
(c) Acid rain can cause damage to buildings made of marble and limestone.
(d) Particulate matter has no significant impact on plant life.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (a), (b) and (c)
(C) (b), (c) and (d)
(D) (a) and (d) only

16. What does the lapse rate in atmospheric science primarily describe?
(A) The rate at which wind speed increases with height.
(B) The rate of change of temperature with an increase in altitude.
(C) The rate of decrease of atmospheric pressure with altitude.
(D) The rate at which pollutants disperse horizontally.

17. A line source model in air pollution dispersion is best suited for modeling emissions from:
(A) A factory smokestack.
(B) A busy highway.
(C) An entire industrial complex.
(D) A forest fire.

18. The principle of operation for a cyclone separator (centrifugal collector) relies mainly on:
(A) Inertia and centrifugal force acting on particles.
(B) The charge of the particles.
(C) The solubility of the pollutant gas.
(D) The condensation of pollutants at low temperatures.

19. Which of the following combinations of processes is used to control gaseous pollutants?
(A) Settling and filtration
(B) Electrostatic precipitation and inertial

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the established salinity gradient suppresses convection to retain the heat in the bottom layer. This stored thermal energy can be extracted for use even when direct sunlight is not available.

291. (C) The splitting of a heavy atomic nucleus into lighter ones.
Nuclear fission is the fundamental physical process where the nucleus of a heavy atom, such as Uranium-235, is split into two or more smaller nuclei. This splitting occurs when the nucleus is struck by a neutron, resulting in the release of a massive amount of energy along with more neutrons. This mechanism is the basis for energy production in reactors.

292. (A) To produce heat at a steady and manageable rate.
In a nuclear reactor, precisely controlling the fission chain reaction is essential to ensure that heat is produced at a constant and manageable rate. By regulating the number of neutrons available to trigger further fission events, operators can maintain a steady thermal output. This heat is then used to generate the steam required to drive turbines for electricity production.

293. (D) As a coolant and a moderator.
In common reactor designs like Pressurized Water Reactors and Boiling Water Reactors, ordinary water performs two critical roles. First, it acts as a coolant, absorbing and transporting the thermal energy generated by fission. Second, it serves as a moderator, which slows down fast-moving neutrons to a speed that more effectively sustains the chain reaction within the enriched uranium fuel.

294. (B) Fusion involves combining light nuclei, while fission involves splitting heavy nuclei.
Nuclear fusion and fission are essentially opposite processes. Fusion involves the combining of light atomic nuclei, such as hydrogen isotopes, to form a heavier nucleus, releasing a tremendous amount of energy. In contrast, fission involves the splitting of heavy, unstable nuclei into smaller fragments. While fission is currently used commercially, fusion represents a potential future source of higher energy density.

295. (C) achieving a controlled and sustained reaction for power generation.
Although nuclear fusion offers the potential for vast amounts of clean energy, it presents formidable scientific and engineering challenges. Achieving and maintaining the extreme temperatures and pressures required for a controlled and sustained fusion reaction on Earth is exceptionally difficult. Current technology has yet to develop a practical and economically viable system that can generate more energy than the process consumes.

296. (D) the release of CO2 leading to global warming.
The global reliance on fossil fuel combustion is identified as the primary driver of anthropogenic climate change. This process releases vast quantities of carbon dioxide into the atmosphere, which is a major greenhouse gas. The accumulation of these gases enhances the natural greenhouse effect, trapping more heat and leading to the phenomenon of global warming and its various environmental impacts.

297. (A) an imbalance in the Earth's energy budget caused by greenhouse gases.
Radiative forcing refers to a net imbalance in the Earth's energy budget caused by factors such as the accumulation of greenhouse gases in the atmosphere. This imbalance occurs when the amount of incoming solar energy is not equal to the amount of energy radiated back into space. This resulting forcing is the fundamental mechanism that drives the current trend of global warming.

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298. (B) Habitat destruction and altered river ecosystems.
Large-scale hydroelectric projects, while providing renewable energy, are associated with significant ecological and social consequences. The construction of massive dams can lead to extensive habitat destruction and the permanent alteration of riverine ecosystems. These projects also frequently cause the displacement of human communities and disrupt the natural flow and sediment transport of rivers, impacting biodiversity and local livelihoods.

299. (B) local bird and bat populations.
One of the documented environmental challenges associated with large-scale wind farms is their impact on local wildlife. The rotating blades of wind turbines have been shown to negatively

(A) Basic Oxygen Depletion
(B) Bicarbonate Organic Deposit
(C) Biological Oxygen Demand
(D) Balanced Oxygen Discharge

30. Consider the following statements about water quality parameters:
(a) pH is a measure of the hydrogen ion concentration.
(b) Turbidity is caused by dissolved solids in water.
(c) DO refers to the concentration of dissolved oxygen in water.
(d) High COD values indicate a low level of organic pollution.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (a) and (c) only
(C) (c) and (d) only
(D) (b), (c) and (d)

31. The 'MPN' test in microbiological analysis of water stands for:
(A) Most Probable Number
(B) Maximum Permissible Number
(C) Minimum Pollution Nuisance
(D) Microbial Presence Notification

32. Indian Standard IS:10500 (2012) primarily specifies the requirements for safe:
(A) Industrial effluent quality
(B) Drinking water
(C) Irrigation water
(D) Recreational water bodies

33. Which chemical is commonly used as a coagulant in drinking water treatment?
(A) Sodium chloride
(B) Aluminum sulfate (Alum)
(C) Calcium carbonate
(D) Sodium hypochlorite

34. The process of removing fine, suspended particles from water after coagulation and flocculation is called:
(A) Sedimentation
(B) Softening
(C) Disinfection
(D) Aeration

35. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Water Treatment Process)
P. Disinfection
Q. Flocculation
S. Softening
R. Filtration
List II: (Purpose)
1. Removal of hardness (Ca_2+, Mg_2+)
2. Killing or inactivating pathogenic microorganisms
3. Agglomeration of small particles into larger flocs
4. Removal of fine suspended solids
(A) P-2, Q-3, R-4, S-1
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-3, S-1
(D) P-3, Q-2, R-1, S-4

36. Which stage of wastewater treatment is primarily physical in nature, involving screening and sedimentation to remove large solids?
(A) Biological secondary treatment
(B) Chemical tertiary treatment
(C) Specialized advanced treatment
(D) Primary treatment

37. The main objective of secondary wastewater treatment is the removal of:
(A) Grit and large floating objects.
(B) Nutrients like nitrogen and phosphorus.
(C) Dissolved organic matter (BOD).
(D) Heavy metals.

38. Given below are two statements:
Statement I : The activated sludge process is a form of secondary wastewater treatment.
Statement II : The activated sludge process relies on aerobic microorganisms to break down organic pollutants.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

39. What is a Common Effluent Treatment Plant (CETP) designed to do?
(A) Treat the industrial wastewater from a single large-scale manufacturing plant.

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CHAPTER 06

Environmental Pollution and Control

1. Which of the following is considered a primary air pollutant?
(A) Ozone
(B) Carbon monoxide
(C) Peroxyacetyl nitrate (PAN)
(D) Sulphuric acid

2. Identify the correct statement regarding secondary air pollutants.
(A) They are formed in the atmosphere through chemical reactions of primary pollutants.
(B) They are emitted directly from a stationary or mobile source into the atmosphere.
(C) Carbon dioxide from combustion is a typical example of a gaseous secondary pollutant.
(D) They are exclusively of natural origin rather than resulting from human activities.

3. Which of the following is an example of an anthropogenic source of air pollution?
(A) Volcanic eruptions
(B) Forest fires
(C) Fossil fuel combustion
(D) Pollen from plants

4. Which category of pollutants includes those formed from the interaction of nitrogen oxides and volatile organic compounds in the presence of sunlight?
(A) Primary pollutants
(B) Criteria air pollutants
(C) Particulate matter
(D) Photochemical oxidants

5. Which of the following is NOT listed as a criteria air pollutant?
(A) Lead
(B) Carbon Monoxide
(C) Carbon Dioxide
(D) Nitrogen Dioxide

6. For effective monitoring of ambient air quality, the 'period' of sampling refers to the:
(A) Total number of air samples taken during a standard measurement day.
(B) Total time over which a single sample is collected.
(C) Elapsed interval between the collection of two consecutive sampling events.
(D) Specific hour of the day when the automated sampling process begins.

7. What is the main principle behind a settling chamber for controlling particulate matter?
(A) Inertial impaction
(B) Centrifugal force
(C) Electrostatic attraction
(D) Gravitational settling

8. Identify the incorrect statement about the dispersion of air pollutants.
(A) A stable atmosphere with a negative lapse rate enhances pollutant dispersion.
(B) Higher wind speeds generally result in the greater dilution of pollutants.
(C) Mixing height determines the vertical volume available for dispersion.
(D) Unstable atmospheric conditions favor the rapid vertical movement of pollutants.

9. Given below are two statements:
Statement I : Acid rain is a secondary pollutant phenomenon.
Statement II : Acid rain is primarily caused by the atmospheric conversion of SO_2 and NOx into H_2SO_4 and HNO_3.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(C) Statement I is false but Statement II is true.

10. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Control Device)
P. Electrostatic Precipitator
Q. Settling Chamber

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of transformations allows the power of the wind to be utilized as a clean energy source.

282. (B) the geothermal gradient.
Several physical variables determine the power output of a wind turbine, including the velocity of the wind and the density of the air. Additionally, the total area swept by the rotating blades directly influences the amount of energy captured. However, the geothermal gradient, which relates to the heat from the Earth's interior, has no impact on wind energy generation.

283. (B) heat from the Earth's interior and radioactive decay.
Geothermal energy is derived from the immense thermal energy stored within the Earth's interior. This heat is primarily generated by the planet's molten core and the natural radioactive decay of elements like uranium and thorium in the crust. This thermal energy is transferred to underground water and steam reservoirs, which can be accessed through deep wells for power generation.

284. (A) It brings high-pressure hot water to the surface, where a pressure drop causes it to turn to steam.
Flash steam geothermal plants operate by accessing high-pressure hot water from deep underground reservoirs. When this superheated water is brought to the surface, it experiences a sudden and significant drop in pressure. This abrupt pressure reduction causes a portion of the water to immediately flash into steam, which is then directed into a turbine to generate electrical power.

285. (C) Wind power uses a kinetic source, while geothermal uses a thermal source.
The fundamental difference between wind power and geothermal energy lies in the nature of the primary energy source. Wind power relies on a kinetic source, specifically the movement of air masses across the Earth's surface. In contrast, geothermal energy utilizes a thermal source, harnessing the heat energy that originates from the radioactive decay and molten core within the planet's interior.

286. (D) A collector generates heat, while a PV module generates electricity.
Solar collectors and photovoltaic modules are designed for entirely different energy conversion pathways. A solar collector is engineered to absorb sunlight and convert it directly into thermal energy, or heat, for various applications. Conversely, a photovoltaic module utilizes the photovoltaic effect within semiconductor materials to convert sunlight directly into electricity, producing a direct current for immediate use or storage.

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287. (C) use mirrors or lenses to focus sunlight to achieve high temperatures.
Concentrating solar collectors use optical components like mirrors or lenses to focus sunlight from a large area onto a much smaller receiver. This concentration significantly increases the intensity of the solar radiation, allowing the system to achieve the high temperatures necessary for industrial processes or large-scale electricity generation. This differs from non-concentrating collectors, which absorb solar energy at its natural intensity.

288. (B) Direct Current (DC)
When photons from sunlight strike the solar cells within a photovoltaic module, they excite electrons and generate an electric current. This initial form of electricity is specifically a direct current. While this current can be used to power certain devices or charge batteries, it often requires conversion into alternating current by an inverter to be compatible with standard electrical power grids.

289. (D) By a salinity gradient that suppresses convection.
A solar pond maintains its heat by utilizing a salinity gradient where the concentration of salt increases with the depth of the water. This gradient prevents natural convection, which would normally cause warmer water to rise to the surface and lose heat to the atmosphere. Consequently, the high-salinity bottom layer traps absorbed solar energy, reaching temperatures much higher than the surface.

290. (A) A solar pond
A solar pond is unique among solar technologies because it functions as both a collection and a storage system for solar energy. The large body of saline water absorbs sunlight, while

impaction
(C) Adsorption and absorption
(D) Flocculation and sedimentation

20. Arrange the following drinking water treatment steps in the correct chronological sequence.
(a) Disinfection
(b) Coagulation and Flocculation
(c) Filtration
(d) Sedimentation
Choose the correct sequence:
(A) b, c, d, a
(B) b, d, c, a
(C) a, b, c, d
(D) d, b, a, c

21. Which noise measurement index represents the sound level that is exceeded for 90% of the measurement time and is often used to represent background noise?
(A) L10
(B) Leq
(C) L90
(D) LDN

22. The A-weighting network in a sound level meter is designed to approximate the:
(A) Loudest possible sound frequency a human can hear.
(B) Frequency response of the human ear at low to moderate sound levels.
(C) Total acoustic energy of a sound, regardless of the input frequency.
(D) Physical impact of heavy mechanical vibrations on structural buildings.

23. Identify the incorrect statement about the noise index.
(A) Leq - The equivalent continuous sound level.
(B) L10 - The sound level exceeded 10% of the time, representing peak noise.
(C) LDN - Day-Night Level, with a penalty for nighttime noise.
(D) L90 - The sound level exceeded 90% of the time, representing the average noise.

24. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Active noise control methods are generally more effective for low-frequency sounds.
Reason (R) : Active noise control works by generating a sound wave with the same amplitude but opposite phase (anti-noise) to the original sound, causing destructive interference.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

25. Which of the following is an example of a passive method for noise abatement?
(A) Using anti-noise generators.
(B) Active vibration damping systems.
(C) Constructing sound barriers along a highway.
(D) Electronic mufflers.

26. Consider the following area types defined in Indian rules for permissible noise levels:
(a) Industrial
(b) Commercial
(c) Residential
(d) Silence Zone
(e) Agricultural Zone
Which of the above statement(s) is/are correct?
(A) (a), (b), and (c) only
(B) (a), (b), (c), and (d) only
(C) (a) and (b) only
(D) (a), (b), (c), (d), and (e)

27. What is the primary health impact associated with long-term exposure to high levels of noise?
(A) Improved concentration
(B) Reduced blood pressure
(C) Enhanced immune system function
(D) Noise-Induced Hearing Loss (NIHL)

28. The unit used to express the equivalent continuous sound level (Leq) is:
(A) Sone
(B) Decibel (dB)
(C) Phon
(D) Hertz (Hz)

29. In the context of water pollution, what does 'BOD' stand for?

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(B) Cold water release from the base of a dam.
(C) Industrial effluent discharge.
(D) Deforestation leading to increased solar radiation on the water surface.

49. Which of the following is a major source of marine pollution?
(A) Controlled industrial effluent discharge on land
(B) Afforestation along coastlines
(C) Oil spills and offshore drilling
(D) Regulated fishing activities

50. Arrange the following stages of wastewater treatment in the correct order.
(a) Sludge digestion
(b) Screening and Grit Removal
(c) Biological treatment (Activated Sludge)
(d) Primary sedimentation
Choose the correct sequence:
(A) b, d, c, a
(B) b, d, c, a
(C) b, c, d, a
(D) a, b, d, c

51. Biological effects of ionizing radiations are primarily due to:
(A) The generation of excess metabolic heat in cellular tissues.
(B) The chemical reactions caused by low-energy non-ionizing radiation.
(C) The general increase in body temperature following environmental exposure.
(D) The damage to molecules, particularly DNA, within cells.

52. What is the fundamental principle of an electrostatic precipitator (ESP)?
(A) Using gravity to settle particles out of a moving air stream.
(B) Charging particles and then collecting them on an oppositely charged surface.
(C) Filtering air through a fabric medium to mechanically trap fine particles.
(D) Using centrifugal force to separate heavy particles from a carrier gas.

53. In the context of National Ambient Air Quality Standards (NAAQS), what does the term 'ambient' refer to?
(A) The air inside a factory.
(B) The air quality at the top of a smokestack.
(C) The air inside a residential building.
(D) The outdoor air in the general environment.

54. The process of converting a gaseous pollutant into a liquid by cooling it is known as:
(A) Condensation
(B) Adsorption
(C) Combustion
(D) Absorption

55. Given below are two statements:
Statement I : Vehicular emissions are a major source of urban air pollution.
Statement II : Catalytic converters in vehicles help reduce emissions of CO, NOx, and hydrocarbons.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

56. Consider the following statements regarding air pollution control devices:
(a) Wet collectors use a liquid spray to wash pollutants from a gas stream.
(b) Fabric filters are highly efficient for removing very fine particulates.
(c) Settling chambers are most effective for large, heavy particles.
(d) Electrostatic precipitators work best for gaseous pollutants.
Which of the statement(s) given above are correct?
(A) (a), (b), and (c)
(B) (b), (c), and (d)
(C) (a), (c), and (d)
(D) (a), (b), and (d)

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57. An area source model for air pollution would be most suitable for:
(A) A single tall chimney.
(B) A residential area with many small chimneys from heating.
(C) A highway with heavy traffic.
(D) A volcanic eruption.

58. Identify the correct pair related to water quality measurement.
(A) DO - Measured using the Winkler method

(B) Treat the domestic sewage from an individual residential apartment building.
(C) Treat the potable drinking water supply for a local rural community.
(D) Treat combined wastewater from a cluster of small-scale industrial units.

40. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : A high BOD value in a water body indicates significant pollution.
Reason (R) : High BOD means a large amount of oxygen is required by microorganisms to decompose the organic waste, depleting the oxygen available for other aquatic life.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

41. Which of the following is NOT typically considered a primary physico-chemical property of soil?
(A) Texture
(B) Structure
(C) pH
(D) Inorganic and organic components

42. Soil texture is determined by the relative proportions of:
(A) Sand, silt, and clay
(B) Water, air, and organic matter
(C) Humus, minerals, and microorganisms
(D) Nitrogen, phosphorus, and potassium

43. Which of the following is a primary function of soil micro-organisms?
(A) Creation of soil structure
(B) Compaction of soil particles
(C) Increasing soil salinity
(D) Degradation of pesticides and synthetic fertilizers

44. Industrial effluents can negatively interact with soil components by:
(A) Improving soil aeration.
(B) Altering soil pH and introducing heavy metals.
(C) Increasing the population of beneficial microbes.
(D) Enhancing the degradation of all synthetic fertilizers.

45. Consider the following statements about soil pollution:
(a) Soil texture refers to the arrangement of soil particles.
(b) Degradation of synthetic fertilizers by microorganisms is always beneficial for the soil ecosystem.
(c) Industrial effluents can contaminate soil with heavy metals.
(d) Soil structure is determined by the percentage of sand, silt, and clay.
(e) Analysis of soil quality involves assessing its physico-chemical and biological properties.
Which of the statement(s) given above are correct?
(A) (a) and (d) only
(B) (c) and (e) only
(C) (a), (b) and (c) only
(D) (c), (d) and (e) only

46. The degradation of pesticides in soil is primarily a:
(A) Physical process
(B) Chemical process
(C) Geological process
(D) Biological process mediated by micro-organisms

47. What is the primary cause of Heat Islands in urban areas?
(A) The replacement of natural surfaces with heat-absorbing materials like asphalt and concrete.
(B) The high concentration of native trees and localized forest vegetation in city centers.
(C) The excessive use of residential air conditioning systems leading to outdoor heat release.
(D) The effects of global warming being significantly more pronounced in urban city locations.

48. All of the following are sources of thermal pollution in water bodies EXCEPT:
(A) Power plant cooling systems.

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affect bird and bat populations through collisions and habitat disruption. While wind is a clean energy source, planners must carefully consider site locations to minimize these ecological footprints and protect local biodiversity.

300. (A) All energy sources, including renewables, have associated environmental impacts that must be considered.

The central argument presented is that every energy source, including renewables, carries certain environmental impacts that must be carefully evaluated. While fossil fuels are major contributors to climate change, solar, wind, hydro, and nuclear power also have specific ecological or safety risks. A sustainable energy strategy requires a balanced approach that weighs energy needs against these diverse and complex consequences.

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or a DO probe
(B) Turbidity - Measured using a standard calibrated pH meter
(C) Hardness - Primarily due to dissolved chlorides and sulphates
(D) pH - Measured by titration with a standard EDTA solution

59. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The presence of phosphates and nitrates in a water body can lead to eutrophication.
Reason (R) : Phosphates and nitrates are essential nutrients that can cause an excessive growth of algae (algal bloom).
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

60. Which of the following best describes the process of absorption for gaseous pollutant control?
(A) Pollutant gas dissolves in a liquid solvent.
(B) Pollutant gas sticks to the surface of a solid.
(C) Pollutant gas is cooled until it becomes a liquid.
(D) Pollutant gas is burned at a high temperature.

61. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Air Pollutant)
P. Carbon Monoxide (CO)
Q. Sulphur Dioxide (SO_2)
R. Particulate Matter (PM2.5)
S. Lead (Pb)
List II: (Primary Health Effect)
1. Neurological and developmental damage
2. Respiratory irritation and bronchoconstriction
3. Reduced oxygen transport in blood
4. Deep lung penetration, cardiovascular issues
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-2, R-4, S-1
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-1, R-4, S-3

62. The 'TNI' (Traffic Noise Index) is a measure used to quantify:
(A) The average background noise in an urban area.
(B) The annoyance caused by fluctuating traffic noise.
(C) The noise level inside a vehicle.
(D) The effectiveness of a noise barrier.

63. Which method of wastewater treatment is specifically designed to remove nutrients like nitrogen and phosphorus?
(A) Primary treatment
(B) Secondary treatment
(C) Advanced treatment
(D) Disinfection

64. What is the primary purpose of adding coagulants like alum during drinking water treatment?
(A) To kill pathogenic bacteria.
(B) To adjust the pH of the water.
(C) To remove dissolved salts and soften the water.
(D) To neutralize and destabilize colloidal particles, allowing them to clump together.

65. Consider the following sources of pollution:
(a) Volcanic eruption
(b) Industrial smokestack
(c) Vehicle exhaust
(d) Forest fire
(e) Respiration from animals
Which of the above are considered anthropogenic sources?
(A) (a), (d), and (e) only
(B) (b) and (c) only
(C) (b), (c), and (e) only
(D) (a), (b), and (c) only

66. What physical property of soil is described as the arrangement of soil particles into aggregates?
(A) Texture
(B) Structure
(C) Porosity
(D) Permeability

67. Consider the following factors regarding the biological effects of ionizing radiation:

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(a) The dose of radiation received.
(b) The type of radiation.
(c) The duration of exposure.
(d) The specific body tissue exposed.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (a), (b), and (c) only
(C) (c) and (d) only
(D) (a), (b), (c), and (d)

68. The measurement of vibrations in structures or the ground is important for assessing:
(A) Potential for structural damage and human annoyance.
(B) Air quality.
(C) Water turbidity.
(D) The level of radioactive contamination.

69. Which of the following is NOT a consequence of thermal pollution in an aquatic ecosystem?
(A) Decreased dissolved oxygen levels.
(B) Increased metabolic rates of aquatic organisms.
(C) Increased growth of beneficial cold-water fish species.
(D) Thermal shock to organisms when temperature changes abruptly.

70. Arrange the following particulate control devices in order of increasing efficiency for fine particles.
(a) Settling Chamber
(b) Centrifugal Collector
(c) Fabric Filter
(d) Electrostatic Precipitator
Choose the correct sequence:
(A) a, b, d, c
(B) a, b, c, d
(C) c, d, b, a
(D) d, c, a, b

71. Coastal management is a practice that aims to:
(A) Promote unrestricted urban development along the existing natural coastline.
(B) Exclusively focus on preventing marine pollution from land-based sources.
(C) Increase the sources of marine pollution for overall regional economic gain.
(D) Balance environmental, economic, and social demands on the coastal zone.

72. What is the term for the total amount of solids remaining in water after it has been filtered and evaporated to dryness?
(A) Turbidity
(B) Total Dissolved Solids (TDS)
(C) Total Suspended Solids (TSS)
(D) Salinity

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73. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : In an unstable atmosphere, pollutants tend to disperse more rapidly.
Reason (R) : An unstable atmosphere is characterized by a super-adiabatic lapse rate, which promotes strong vertical air movement.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

74. The process of using microorganisms to degrade synthetic fertilizers and pesticides in soil is a key component of:
(A) Soil salinization
(B) Soil compaction
(C) Desertification
(D) Bioremediation

75. L50, in noise measurement, represents the sound level that is exceeded for:
(A) 50% of the measurement time, often considered the median noise level.
(B) 10% of the total measurement time, representing the specific peak noise.
(C) 90% of the total measurement time, representing the constant background noise.
(D) The entire total duration of the measurement from start to finish.

76. In the context of stack emission monitoring, what is the primary purpose?
(A) To measure the general outdoor ambient air quality of a metropolitan city.
(B) To quantify the rate and concentration of pollutants being discharged from a specific source.

(C) To determine the impact of acid rain on building materials and structural surfaces.
(D) To monitor the air quality inside residential and commercial buildings.

77. Which of the following is a key component of a fabric filter's (baghouse) operation?
(A) High-voltage electrodes
(B) A series of woven or felted bags that capture dust
(C) A liquid scrubbing medium
(D) A vortex-creating chamber

78. The interaction of industrial effluents with soil can lead to the accumulation of _____, which can then enter the food chain.
(A) Heavy metals
(B) Organic matter
(C) Beneficial microbes
(D) Essential nutrients

79. Given below are two statements:
Statement I : Hardness in water is primarily caused by the presence of dissolved bicarbonates, chlorides, and sulfates of calcium and magnesium.
Statement II : Water softening is the process of removing these hardness-causing ions.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

80. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Pollution Type)
P. Acid Rain
Q. Heat Island
R. Eutrophication
S. Marine Pollution
List II: (Primary Source/Cause)
1. Nutrient runoff (N, P) into water bodies
2. SOx and NOx emissions
3. Oil spills
4. Urban surfaces absorbing solar radiation
(A) P-1, Q-3, R-2, S-4
(B) P-2, Q-4, R-1, S-3
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-2, R-3, S-1

81. Which one of the following is a significant source of indoor air pollution?
(A) Industrial stack emissions from heavy manufacturing.
(B) Agricultural pesticides sprayed on open crop fields.
(C) Volcanic ash from active geological eruptions.
(D) Volatile organic compounds (VOCs) from paints and furnishings.

82. The 'duration' of air quality sampling is a critical parameter because:
(A) It must always be exactly 24 hours to ensure high accuracy.
(B) It helps capture representative concentrations, especially for pollutants that vary over time.
(C) Longer durations always give less accurate and less precise results.
(D) It is only important for particulate matter monitoring, not for gaseous pollutants.

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83. Consider the following statements about radioactive pollution:
(a) All radiation is man-made.
(b) Ionizing radiation has enough energy to remove tightly bound electrons from atoms.
(c) Radiation standards are set to completely eliminate any biological risk.
(d) Radiation protection involves principles like time, distance, and shielding.
(e) The biological effects of radiation are always immediately visible.
Which of the above statement(s) is/are correct?
(A) (a) and (e) only
(B) (b) and (d) only
(C) (c), (d), and (e)
(D) (a), (b), and (c)

84. The measurement of Electrical Conductivity (EC) in a water sample provides an indication of:
(A) The concentration of dissolved oxygen in the liquid.
(B) The water's specific ambient and internal temperature.
(C) The presence of pathogenic and harmful bacteria.
(D) The total amount of dissolved ionic substances (salts).

(D) The synthesis of pesticides.

122. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Term)
P. Adsorption
Q. Absorption
R. Condensation
S. Combustion
List II: (Definition)
1. Gas dissolves into the bulk of a liquid
2. Gas adheres to the surface of a solid
3. High-temperature oxidation reaction
4. Phase change from gas to liquid
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-2, Q-1, R-3, S-4
(D) P-1, Q-2, R-4, S-3

123. Which gas is a precursor to acid rain and is primarily produced by the burning of coal?
(A) Carbon Monoxide (CO)
(B) Methane (CH_4)
(C) Ozone (O_3)
(D) Sulphur Dioxide (SO_2)

124. Consider the following parameters for which the Indian standard for drinking water, IS:10500, specifies limits:
(a) Physical parameters like turbidity and color.
(b) Chemical parameters like hardness and chlorides.
(c) Bacteriological parameters like coliforms.
(d) Radioactive substances.
(e) Parameters related to industrial process efficiency.
Which of the above statement(s) is/are correct?
(A) (a), (b), and (c) only
(B) (a), (b), (c), and (d) only
(C) (a) and (b) only
(D) (a), (b), (c), (d), and (e)

125. The process of flocculation in water treatment is enhanced by:
(A) Slow, gentle stirring.
(B) Rapid, vigorous mixing.
(C) Adding a strong acid.
(D) Increasing the water temperature to boiling.

126. A super-adiabatic lapse rate indicates which atmospheric condition?
(A) Extremely stable
(B) Unstable
(C) Neutral
(D) An inversion

127. Which of the following is a primary objective of secondary wastewater treatment?
(A) Removal of grit and large solids.
(B) Removal of dissolved organic matter through biological processes.
(C) Removal of nitrogen and phosphorus.
(D) Disinfection of the final effluent.

128. Vibrations can be a source of pollution because they can cause:
(A) Annoyance to humans and structural damage to buildings.
(B) An increase in air temperature.
(C) Eutrophication of water bodies.
(D) The formation of secondary air pollutants.

129. Among the following, which air pollution control device has the highest collection efficiency for sub-micron (very fine) particles?
(A) Settling chamber
(B) Cyclone separator
(C) Electrostatic precipitator
(D) Simple spray tower

130. Given below are two statements:
Statement I : The noise index L10 is the sound level exceeded for 10% of the time.
Statement II : L10 is often used to represent the intrusive or peak noise levels in a fluctuating noise environment, such as from passing traffic.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

131. Which of the following water quality parameters is a measure of the light-scattering properties of suspended particles in water?
(A) TDS
(B) EC
(C) pH
(D) Turbidity

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(B) To remove dissolved gases like carbon dioxide.
(C) To adjust the pH level to a neutral range.
(D) To remove fine suspended particles and flocs that did not settle out.

95. Consider the following statements about soil properties:
(a) Soil texture is the percentage of sand, silt, and clay.
(b) Soil structure is the arrangement of soil particles into aggregates.
(c) The inorganic components of soil are derived from weathered rock.
(d) Organic components of soil primarily consist of living organisms and decaying matter.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (c) and (d) only
(C) (a), (b), and (c) only
(D) (a), (b), (c), and (d)

96. The term 'radiation exposure' refers to:
(A) The amount of radioactive material in the environment.
(B) The process of being exposed to ionizing radiation.
(C) The standards set for safe levels of radiation.
(D) The biological damage caused by radiation.

97. The difference between BOD and COD for a given water sample is that:
(A) COD measures only biodegradable organics, while BOD measures all oxidizable compounds.
(B) BOD is a biological test, while COD is a chemical test conducted in a laboratory.
(C) BOD is always higher than COD for the same environmental water sample.
(D) BOD measures only biodegradable organics, while COD measures nearly all oxidizable compounds.

98. Which of the following is an example of an 'active' noise control method?
(A) Using an electronic system to generate 'anti-noise'.
(B) Building a thick, sound-insulating concrete wall.
(C) Planting a wide belt of trees for sound absorption.
(D) Wearing personal earplugs for hearing protection.

99. In the Gaussian plume model, under which atmospheric condition would the plume be fanning, i.e., spreading horizontally with very little vertical mixing?
(A) Strong instability (super-adiabatic)
(B) Neutral
(C) Strong inversion (stable)
(D) Looping

100. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Water Quality Parameter)
P. Hardness
Q. Turbidity
R. Chlorides
S. Nitrates
List II: (Significance/Cause)
1. Presence of suspended or colloidal matter
2. Presence of Calcium and Magnesium ions
3. Indication of fertilizer runoff or sewage contamination
4. Can indicate sewage pollution or saline intrusion
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-3, R-4, S-1

101. What is a major environmental concern associated with the use of synthetic fertilizers in agriculture?
(A) They improve soil structure permanently for years.
(B) They are completely degraded by microorganisms quickly.
(C) They reduce the total need for seasonal irrigation.
(D) They can be leached into groundwater and cause nitrate pollution.

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102. Which of the following is NOT a principle of radiation protection?
(A) Minimizing time of exposure.
(B) Increasing the intensity of the radiation source.
(C) Maximizing distance from the source.

141. The final step in most municipal drinking water treatment plants, designed to prevent waterborne diseases, is:
(A) Coagulation
(B) Sedimentation
(C) Disinfection
(D) Filtration

142. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Noise Index)
P. Leq
Q. L10
R. L90
S. LDN
List II: (Typical Application)
1. Background noise level
2. Community noise assessment including nighttime penalty
3. Overall energy-equivalent average noise level
4. Peak or intrusive noise events (e.g., traffic)
(A) P-3, Q-4, R-1, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-4, Q-3, R-2, S-1

143. Which of the following is a key component of coastal management strategies?
(A) Encouraging unlimited sand mining from beaches.
(B) Discharging untreated industrial waste into estuaries.
(C) Building high-rise structures directly on the shoreline.
(D) Protecting coastal ecosystems like mangroves and coral reefs.

144. The process where gaseous pollutants are burned at very high temperatures is called:
(A) Absorption
(B) Incineration or Combustion
(C) Adsorption
(D) Condensation

145. Consider the following statements regarding noise and vibrations:
(a) Weighting networks are used in sound level meters.
(b) Active noise control uses sound barriers.
(c) Vibrations can be measured and have health impacts.
(d) L90 represents the peak noise level.
(e) Passive noise control involves anti-noise generation.
Which of the statement(s) given above are correct?
(A) (a) and (c) only
(B) (a), (b), and (c) only
(C) (d) and (e) only
(D) (a), (c), and (d) only

146. A cone of depression is a term associated with:
(A) The shape of a pollutant plume from a chimney.
(B) The pattern of noise radiating from a source.
(C) The settlement of land due to underground mining.
(D) The lowering of the water table around a pumping well.

147. Which of the following is a secondary air pollutant formed in photochemical smog?
(A) Carbon monoxide (CO)
(B) Ozone (O_3)
(C) Sulphur dioxide (SO_2)
(D) Lead (Pb)

148. The primary mechanism for the removal of pollutants in a trickling filter (a type of secondary wastewater treatment) is:
(A) Biological oxidation by a biofilm of microorganisms.
(B) Physical filtration through a sand bed.
(C) Chemical precipitation with alum.
(D) Adsorption onto activated carbon.

149. The Indian National Ambient Air Quality Standards (NAAQS) specify different limits for which categories of areas?
(A) Urban and Rural Areas
(B) Northern and Southern India
(C) Industrial, Residential, Rural and Ecologically Sensitive Areas
(D) High altitude and Low altitude areas

150. Arrange the following forms of ionizing radiation in order of increasing penetrating power.
(a) Alpha particles
(b) Gamma rays

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(C) The wavelength of the optical instrument used for analysis.
(D) The height above ground level at which the sample is taken.

113. The principle behind fabric filters is most analogous to:
(A) A magnet attracting iron filings.
(B) A fan blowing air.
(C) A coffee filter.
(D) Water dissolving salt.

114. Given below are two statements:
Statement I : Centrifugal collectors (cyclones) are highly efficient for removing very fine particles (< 1 micron).
Statement II : The separation principle in cyclones relies on gravity, which is less effective for smaller, lighter particles.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

115. Which of the following is NOT an impact of noise on human health?
(A) Increased acuity of hearing.
(B) Sleep disturbance.
(C) Annoyance and psychological stress.
(D) Hypertension and cardiovascular issues.

116. Consider the following statements regarding water pollution sources:
(a) Point sources discharge pollutants at specific locations through pipes or channels.
(b) Agricultural runoff is an example of a point source.
(c) Non-point sources are diffuse and deliver pollutants indirectly.
(d) Urban stormwater runoff is an example of a non-point source.
Which of the statement(s) given above are correct?
(A) (a), (b), and (c)
(B) (b), (c), and (d)
(C) (a), (c), and (d)
(D) (a), (b), and (d)

117. What does COD (Chemical Oxygen Demand) measure in a water sample?
(A) The amount of oxygen needed for biological decomposition of substances.
(B) The amount of oxygen required to chemically oxidize both biodegradable and non-biodegradable organic matter.
(C) The concentration of dissolved oxygen currently available in the water.
(D) The amount of chlorine gas required for effective primary disinfection.

118. In soil science, what does 'texture' refer to?
(A) The relative proportions of sand, silt, and clay.
(B) The mineral composition of the soil.
(C) The arrangement of soil particles.
(D) The amount of organic matter in the soil.

119. The primary purpose of a Common Effluent Treatment Plant (CETP) is to:
(A) Provide clean drinking water to industrial areas.
(B) Treat effluent from a single, large-scale industry.
(C) Offer a centralized treatment facility for effluents from a group of small and medium-sized enterprises.
(D) Treat the domestic sewage from an entire metropolitan city.

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120. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Marine pollution is often a trans-boundary problem.
Reason (R) : Ocean currents and marine life can transport pollutants far from their original source.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

121. The main function of soil microorganisms in a healthy ecosystem includes:
(A) Increasing soil compaction.
(B) The creation of heavy metals.
(C) The decomposition of organic matter and nutrient cycling.

(D) Using appropriate shielding.

103. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Coagulation and flocculation are essential steps before sedimentation in water treatment.
Reason (R) : These processes help small, stable colloidal particles to destabilize and aggregate into larger, heavier flocs that can settle by gravity.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

104. The mixing height or mixing depth is best defined as:
(A) The altitude at which clouds begin to form.
(B) The height of the tallest smokestack in a region.
(C) The depth of the ocean where pollutants are concentrated.
(D) The vertical extent of the atmospheric layer in which pollutants can be mixed by turbulence.

105. Consider the following parameters for measuring water quality:
(a) pH
(b) BOD
(c) TDS
(d) MPN
(e) Heavy metals
Which of the above statement(s) is/are correct?
(A) (a), (b), and (c) only
(B) (a), (b), (c), and (d) only
(C) (a) and (e) only
(D) (a), (b), (c), (d), and (e)

106. A primary pollutant is one that is:
(A) Formed in the atmosphere through chemical reactions.
(B) Emitted directly into the atmosphere from a source.
(C) Only harmful to human health and not to plants.
(D) Less toxic than a secondary pollutant.

107. The main purpose of disinfection in drinking water treatment is to:
(A) Remove suspended solids.
(B) Kill or inactivate pathogenic microorganisms.
(C) Improve the taste and odor of water.
(D) Remove hardness from the water.

108. The phenomenon where an urban area is significantly warmer than its surrounding rural areas is known as:
(A) A heat island.
(B) The greenhouse effect.
(C) Thermal pollution.
(D) An inversion layer.

109. Which of the following is a natural source of air pollution?
(A) Emissions from an automobile.
(B) Smoke from a factory.
(C) Ash from a volcanic eruption.
(D) Fumes from a paint shop.

110. Arrange the following events in the formation of photochemical smog in the correct sequence.
(a) Formation of ozone and other oxidants.
(b) Emission of NOx and VOCs.
(c) Sunlight acts on the primary pollutants.
(d) Reaction of atomic oxygen with molecular oxygen.
Choose the correct sequence:
(A) b, c, d, a
(B) a, b, c, d
(C) b, a, c, d
(D) c, b, a, d

111. Which of the following statements about acid rain is incorrect?
(A) It is caused by atmospheric SO2 and NOx.
(B) It can lower the pH of lakes and soils.
(C) It can cause deterioration of building materials like marble.
(D) It primarily consists of carbonic acid from atmospheric CO_2

112. In air quality monitoring, frequency of sampling refers to:
(A) The total time taken for one specific air sample.
(B) The number of samples collected in a given time period (e.g., per day or per week).

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132. Consider the following statements about urban air quality:
(a) Vehicular emissions are a major contributor.
(b) The heat island effect can trap pollutants.
(c) Urban areas typically have lower concentrations of ozone than pristine forests.
(d) Line source models are often used to model pollution from city streets.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (a), (b), and (d)
(C) (c) and (d) only
(D) (a), (b), (c), and (d)

133. The 'noise dose' is a concept used to quantify:
(A) The quietest sound a person can hear.
(B) The frequency of a sound.
(C) The total sound energy a person is exposed to over a period, relative to a standard.
(D) The distance a sound travels before becoming inaudible.

134. What is the role of microorganisms in the degradation of synthetic fertilizers in soil?
(A) They convert the fertilizers into toxic heavy metals.
(B) They prevent fertilizers from being absorbed by plants.
(C) They have no role in the degradation of synthetic fertilizers.
(D) They break down complex organic and inorganic compounds into simpler forms.

135. The primary consequence of thermal pollution on aquatic life is related to:
(A) The reduction of dissolved oxygen concentration in water.
(B) The increase in water density.
(C) The improvement in water clarity.
(D) The decrease in the metabolic rate of fish.

136. Which of the following is NOT a source of radioactive pollution?
(A) Nuclear power plant accidents.
(B) Combustion of natural gas for heating.
(C) Mining of uranium ores.
(D) Medical use of radioisotopes.

137. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Landfills and waste dumps can be a major source of soil and groundwater pollution.
Reason (R) : Leachate, a contaminated liquid from waste decomposition, can percolate through the soil and contaminate underlying aquifers.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

138. The principle of a wet collector (scrubber) involves:
(A) Using electrical fields to charge particles.
(B) Using gravity to settle out large particles.
(C) Using a fabric bag to filter out dust.
(D) Using a liquid (usually water) to capture pollutants.

139. In a stable atmosphere with an inversion layer, how would a plume from a tall stack behave if the stack height is above the inversion layer?
(A) The plume would be trapped below the inversion and cause high ground-level concentrations.
(B) The plume would disperse above the inversion layer with little to no impact on ground-level concentrations.
(C) The plume would disperse rapidly in all directions.
(D) The plume would mix downwards into the inversion layer.

140. Which of the following statements about soil is incorrect?
(A) Soil organic components include only living microorganisms.
(B) Soil texture relates to the size of particles.
(C) Soil structure relates to the arrangement of particles.
(D) Industrial effluents can alter the physico-chemical properties of soil.

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85. Which of the following is a method for the abatement of marine pollution?
(A) Implementing and enforcing international conventions like MARPOL.
(B) Increasing the number of offshore oil rigs for resource extraction.
(C) Discharging untreated sewage directly into localized coastal waters.
(D) Promoting the use of single-use plastics on commercial ships.

86. Catalytic combustion is a control method for gaseous pollutants that:
(A) Dissolves the gas in a liquid through high-pressure absorption.
(B) Uses a catalyst to promote oxidation (burning) of the pollutant at a lower temperature.
(C) Cools the gas stream until the pollutant undergoes a phase change.
(D) Traps the pollutant on the surface of a solid like activated carbon.

87. Which of these is a measure of the difference between the actual temperature profile and the dry adiabatic lapse rate?
(A) Total mixing height of the local atmosphere.
(B) Atmospheric stability of the given region.
(C) Wind speed and direction at stack height.
(D) Plume rise above the exit point of the chimney.

88. The most probable number (MPN) technique is a statistical method used to estimate the concentration of which of the following in water?
(A) Viable coliform bacteria
(B) Heavy metals
(C) Dissolved solids
(D) Nitrates

89. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Wet collectors (scrubbers) can remove both particulate matter and gaseous pollutants.
Reason (R) : The scrubbing liquid can physically capture particles and chemically react with or absorb soluble gases.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

90. Which of the following is a key characteristic of a secondary air pollutant?
(A) It is formed by chemical reactions in the atmosphere.
(B) It is emitted directly from a source.
(C) Its concentration is highest near the emission source.
(D) It consists mainly of large particulate matter.

91. Arrange the following steps of the activated sludge process in logical order.
(a) Aeration Tank
(b) Final Clarifier (Secondary Settling)
(c) Return Activated Sludge (RAS) line
(d) Effluent Discharge
Choose the correct sequence:
(A) a, b, c, d
(B) b, a, c, d
(C) a, c, b, d
(D) a, b, d, c

92. The effectiveness of a settling chamber as a particulate control device increases with:
(A) Increasing gas velocity and decreasing particle size.
(B) Decreasing gas velocity and increasing particle size and density.
(C) Increasing gas velocity and increasing particle size.
(D) Decreasing gas velocity and decreasing particle size.

93. The LDN (Day-Night Average Sound Level) adds a 10 dB penalty to noise levels during which period?
(A) Daytime hours (7 AM to 10 PM)
(B) Evening hours (7 PM to 10 PM)
(C) Nighttime hours (10 PM to 7 AM)
(D) Morning hours (6 AM to 10 AM)

94. What is the primary purpose of filtration in the drinking water treatment process?
(A) To kill microorganisms through chemical treatment.

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(c) Beta particles
Choose the correct sequence:
(A) a, b, c
(B) c, a, b
(C) a, c, b
(D) b, c, a

151. An 'area source model' in air quality modeling is used to represent emissions from:
(A) A single factory chimney.
(B) A long, straight highway.
(C) An airplane flying at high altitude.
(D) A wide geographical area with multiple small, diffuse sources, like a residential neighborhood.

152. The measurement of Total Dissolved Solids (TDS) is closely related to which other water quality parameter?
(A) pH
(B) Electrical Conductivity (EC)
(C) Dissolved Oxygen (DO)
(D) Turbidity

153. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Fabric filters (baghouses) require periodic cleaning.
Reason (R) : Over time, the collected dust cake on the fabric increases the pressure drop, reducing airflow and filtration efficiency if not removed.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

154. What is the primary environmental concern with the discharge of raw or undertreated sewage into a river?
(A) It increases the water temperature.
(B) It increases the salinity of the river.
(C) It makes the river water more acidic.
(D) It causes a rapid depletion of dissolved oxygen.

155. Given below are two statements:
Statement I : Advanced wastewater treatment is sometimes called tertiary treatment.
Statement II : The main purpose of advanced treatment is the removal of specific pollutants not removed in secondary treatment, such as nutrients and residual solids.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

156. In the context of soil pollution, the interaction of industrial effluents with soil components depends heavily on:
(A) The time of day of the discharge.
(B) The pH of the effluent and the buffering capacity of the soil.
(C) The wind speed at the time of discharge.
(D) The color of the effluent.

157. Which of the following is considered a passive method of noise control?
(A) Using active noise cancellation headphones.
(B) Constructing an acoustic barrier or wall.
(C) An electronic muffler on a car.
(D) A white noise machine.

158. Which of the following statements correctly describes the effect of acid rain on materials?
(A) It causes the corrosion of metals and erosion of limestone and marble.
(B) It strengthens concrete structures.
(C) It cleans and preserves metal surfaces.
(D) It has no effect on man-made materials.

159. Consider the following statements about water quality parameters:
(a) A pH of 7 is neutral.
(b) Hardness is mainly caused by Na+ and K+ ions.
(c) High turbidity reduces light penetration in water.
(d) Salinity is a measure of dissolved salts.
(e) BOD is a measure of dissolved oxygen.
Which of the statement(s) given above are correct?
(A) (a), (c) and (d) only
(B) (b), (d) and (e) only
(C) (a), (b) and (e) only
(D) (c), (d) and (e) only

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(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

Direction : Please read the following source carefully.

The study of air pollution begins with the fundamental classification of pollutants based on their origin and formation. Sources are broadly categorized as natural, such as volcanic eruptions or forest fires, and anthropogenic, which result from human activities like industrial processes and vehicular emissions. Pollutants themselves are divided into two main types: primary and secondary. Primary pollutants are substances emitted directly into the atmosphere from a discernible source. Examples include sulfur dioxide (SO_2), carbon monoxide (CO), and particulate matter released from industrial stacks. In contrast, secondary pollutants are not emitted directly but are formed in the atmosphere through chemical reactions involving primary pollutants and other atmospheric constituents, often driven by sunlight. Ozone (O_3) formed in photochemical smog is a classic example of a secondary pollutant, created from reactions involving nitrogen oxides (NOx) and volatile organic compounds (VOCs). The concept of 'criteria air pollutants' refers to a group of common pollutants regulated by environmental agencies due to their widespread presence and potential to endanger public health and welfare. Understanding the distinction between these categories is crucial for developing effective monitoring and control strategies, as targeting primary pollutant sources can prevent the formation of harmful secondary pollutants.

Based on the above source, attempt the following five questions.

251. Which of the following statements most accurately describes the distinction between primary and secondary air pollutants?
(A) Primary pollutants are natural, while secondary pollutants are anthropogenic.
(B) Primary pollutants are directly emitted, while secondary pollutants are formed through atmospheric chemical reactions.
(C) Primary pollutants are gaseous, while secondary pollutants are particulate.
(D) Primary pollutants are less harmful than secondary pollutants.

252. According to the passage, a substance like ozone formed from reactions involving nitrogen oxides and volatile organic compounds in the presence of sunlight is classified as:
(A) A secondary pollutant
(B) A criteria primary pollutant
(C) An anthropogenic primary pollutant
(D) A natural secondary pollutant

253. The term 'criteria air pollutants' is used for a set of pollutants primarily because they are:
(A) Exclusively secondary in nature
(B) Only found in urban areas
(C) Widely present and pose a significant risk to public health
(D) Only produced by natural sources

254. Based on the information provided, what can be inferred about effective air pollution control strategies?
(A) They should focus exclusively on capturing secondary pollutants from the air.
(B) They are most effective when they prioritize controlling natural sources over anthropogenic ones.
(C) They are only necessary for pollutants classified as 'criteria air pollutants'.
(D) They can be enhanced by managing the emission of primary pollutants to inhibit secondary pollutant formation.

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255. Which of the following pairs correctly matches a source category with a pollutant type as described in the passage?
(A) Natural source : Ozone formed in smog
(B) Primary pollutant : Photochemical smog
(C) Anthropogenic source : Carbon monoxide from vehicular emissions
(D) Secondary pollutant : Sulfur dioxide from a factory

Direction : Please read the following source carefully.

The effective management of air quality necessitates a robust framework for sampling and monitoring pollutants. This process involves strategic decisions regarding the period, frequency, and duration of sampling to obtain representative data. Monitoring can be broadly divided into two domains: assessing ambient air quality, which pertains to the general outdoor

171. Soil texture is defined by the relative proportions of:
(A) Humus, water, and air
(B) Minerals, organic matter, and microorganisms
(C) Sand, silt, and clay
(D) Nitrogen, phosphorus, and potassium

172. The term 'Heat Island' describes:
(A) A naturally warm area in a desert.
(B) An urban area that is significantly warmer than its surroundings.
(C) A source of thermal pollution in a river.
(D) The effect of global warming on polar ice caps.

173. What is the main principle of a cyclone separator (centrifugal collector)?
(A) Gravitational force
(B) Inertia and centrifugal force
(C) Electrostatic charge
(D) Filtration through a porous medium

174. Given below are two statements:
Statement I : BOD is the oxygen required by microorganisms to biodegrade organic matter.
Statement II : COD is the oxygen required to chemically oxidize organic matter.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

175. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Process)
P. Coagulation
S. Softening
R. Filtration
Q. Disinfection
List II: (Objective in Water Treatment)
1. Kill pathogens
2. Remove fine suspended solids
3. Destabilize colloids
4. Remove Ca_2+ and Mg_2+ ions
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-2, S-1

176. Which of the following is a major consequence of marine pollution?
(A) Increased biodiversity of coral reefs.
(B) Damage to marine ecosystems and contamination of seafood.
(C) Reduction in sea level.
(D) Improvement in the clarity of coastal waters.

177. The degradation of pesticides in soil is primarily carried out by:
(A) Sunlight
(B) High temperatures
(C) Soil micro-organisms
(D) Heavy metals

178. What does the term 'mixing depth' signify in air pollution meteorology?
(A) The depth of the ocean where pollutants are mixed.
(B) The depth of a mixing tank in a treatment plant.
(C) The horizontal distance over which pollutants mix.
(D) The vertical height available for pollutant dispersion.

179. Consider the following methods for the control of gaseous pollutants:
(a) Adsorption
(b) Absorption
(c) Condensation
(d) Combustion
(e) Settling chamber
Which of the above statement(s) is/are correct?
(A) (a), (b) and (c) only
(B) (a), (b), (c) and (d) only
(C) (e) only
(D) (a), (b), (c), (d) and (e)

180. The primary purpose of flocculation is to:
(A) Kill bacteria through chemical means.
(B) Encourage small particles to aggregate into larger flocs.
(C) Filter out sand and gravel.
(D) Settle heavy solids by gravity.

181. A 'line source' in air pollution modeling typically represents:
(A) A factory smokestack.
(B) A busy highway.
(C) A whole city.

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227. In soil science, what does 'structure' refer to?
(A) The percentage of sand, silt, and clay.
(B) The arrangement of soil particles into aggregates.
(C) The mineral content of the soil.
(D) The depth of the topsoil.

228. Which of these is a secondary air pollutant?
(A) Ozone formed in the troposphere
(B) Carbon Monoxide from a car
(C) Sulphur Dioxide from a factory
(D) Soot from a fire

229. Consider the following statements about water treatment:
(a) Coagulation helps destabilize particles.
(b) Flocculation involves slow mixing to form flocs.
(c) Sedimentation removes flocs by gravity.
(d) Filtration removes finer remaining particles.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (a), (b), and (c) only
(C) (c) and (d) only
(D) (a), (b), (c), and (d)

230. Vibrations are considered a pollutant because they can cause:
(A) Air pollution
(B) Human health effects and structural damage
(C) Water contamination
(D) Eutrophication

231. The primary treatment of wastewater mainly involves:
(A) Secondary biological processes.
(B) Physical processes like screening and sedimentation.
(C) Chemical tertiary disinfection.
(D) Advanced nutrient removal.

232. An electrostatic precipitator is used to control:
(A) Particulate matter.
(B) Gaseous pollutants.
(C) Noise pollution.
(D) Water pollution.

233. The 'period' of air sampling refers to the:
(A) Particular time of day.
(B) Time interval between samples.
(C) Total time over which a single sample is collected.
(D) Specific season of the year.

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234. Which of these is NOT a source of thermal pollution?
(A) Power plant cooling water
(B) Industrial effluent
(C) Urban runoff from hot pavement
(D) Release of cold water from a dam's base

235. The main function of a settling chamber is to remove:
(A) Fine particles from a gas stream.
(B) Gaseous pollutants.
(C) Large, heavy particles from a gas stream.
(D) Dissolved solids from water.

236. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Noise barriers along highways can be an effective passive noise control measure.
Reason (R) : Barriers work by reflecting and absorbing sound energy, creating a shadow zone of reduced noise levels on the other side.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

237. Which of the following is NOT typically measured as a water quality parameter?
(A) pH
(B) DO
(C) BOD
(D) Leq

238. What does microbiological analysis - MPN test for in water?
(A) THE concentration of toxic heavy metals.
(B) The probable number of coliform bacteria.
(C) The presence of organic contaminants.
(D) The turbidity of the liquid sample.

239. The degradation of pesticides in soil is an important function of:
(A) Soil fauna like earthworms.

(D) Analyzing soil contamination.

194. Given below are two statements:
Statement I : Chlorination is a common method for disinfecting drinking water.
Statement II : Chlorine is effective at killing or inactivating most pathogenic microorganisms.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

195. Consider the following sources of pollution:
(a) Oil spills
(b) Industrial effluents
(c) Agricultural runoff
(d) Sewage discharge
(e) Offshore drilling
Which of the above are sources of Marine Pollution?
(A) (a) and (b) only
(B) (a), (b) and (d) only
(C) (a), (b), (c) and (d) only
(D) (a), (b), (c), (d) and (e)

196. The main objective of 'Coastal Management' is to:
(A) Promote rapid industrialization of the coastline.
(B) Sustainably manage the resources of the coastal zone.
(C) Stop all human activity in coastal areas.
(D) Focus solely on preventing beach erosion.

197. Which of the following statements about soil pollution is correct?
(A) Synthetic fertilizers always improve the long-term health of soil.
(B) Soil microorganisms are not affected by pollutants.
(C) Soil texture and structure are irrelevant to pollution control.
(D) Industrial effluents can introduce persistent toxic metals into the soil.

198. In water quality analysis, the parameter 'hardness' is primarily caused by:
(A) Calcium and magnesium ions.
(B) Sodium and potassium ions.
(C) Chlorides and sulfates.
(D) Suspended solids.

199. What is the consequence of high BOD in a river?
(A) Increase in fish population.
(B) THE water becomes clearer.
(C) Depletion of dissolved oxygen, potentially leading to fish kills.
(D) The water temperature decreases.

200. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Pollutant)
P. Carbon Monoxide
Q. Ozone
R. Dust
S. PAN
List II: (Type)
1. Secondary Pollutant
2. Primary Pollutant (Gaseous)
3. Secondary Pollutant
4. Primary Pollutant (Particulate)
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-4, Q-1, R-2, S-3

201. Which principle is used in fabric filters to remove particulate matter?
(A) Gravitational settling
(B) Centrifugal force
(C) Electrostatic attraction
(D) Sieving and interception

202. The chemical formula for Ozone is:
(A) O_2
(B) O_3
(C) SO_2
(D) NO_2

203. Active noise control involves:
(A) Building a sound barrier.
(B) Planting trees to absorb sound.
(C) Generating an out-of-phase sound wave.
(D) Wearing earplugs.

204. The term 'physico-chemical' properties of soil refers to properties like:
(A) The types of microorganisms present.
(B) The amount of rainfall the soil receives.
(C) The slope of the land.

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160. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Device/Model)
P. Gaussian Plume Model
Q. Wet Collector
R. Fabric Filter
S. Leq Meter
List II: (Application)
1. Measuring average noise level
2. Removing dry particulate matter
3. Predicting dispersion from a point source
4. Removing particulates and soluble gases
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-2, R-4, S-1
(D) P-1, Q-4, R-2, S-3

161. THE biological effects of ionizing radiations are due to their ability to:
(A) Increase the temperature of biological tissue.
(B) Cause vibrations in cell structures.
(C) Deplete oxygen from the blood.
(D) Create ions and free radicals within cells, damaging DNA.

162. The 'softening' of water is a treatment process that specifically aims to remove:
(A) Suspended solids.
(B) Dissolved ions of calcium and magnesium.
(C) Pathogenic bacteria.
(D) Unpleasant odors.

163. Which of the following is a primary air pollutant?
(A) Ozone
(B) Sulfuric acid mist
(C) Nitrogen dioxide (NO_2)
(D) Peroxyacetyl nitrate (PAN)

164. In the context of sampling, the frequency determines:
(A) How long each sample is collected for.
(B) The total volume of air sampled.
(C) The analytical instrument used.
(D) How often samples are collected.

165. The term 'lapse rate' refers to the rate of change of which parameter with altitude?
(A) Pressure
(B) Humidity
(C) Temperature
(D) Wind speed

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166. Consider the following statements about particulate control devices:
(a) Settling chambers use gravity.
(b) Centrifugal collectors use inertia.
(c) Fabric filters can remove very fine particles.
(d) ESPs charge particles before collection.
Which of the above statement(s) is/are correct?
(A) (a) and (b) only
(B) (c) and (d) only
(C) (a), (b) and (c) only
(D) (a), (b), (c) and (d)

167. Which of the following is a method for controlling gaseous pollutants?
(A) Electrostatic precipitator
(B) Fabric filter
(C) Settling chamber
(D) Absorption

168. The A-weighting network on a sound level meter is designed to mimic the:
(A) Response of the human ear.
(B) Total sound power.
(C) Frequency of vibrations.
(D) Sound reflection from surfaces.

169. L90 is the noise level that is exceeded for 90% of the time and is a good indicator of:
(A) Peak traffic noise.
(B) Average noise level.
(C) Background noise.
(D) Annoyance level.

170. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Secondary wastewater treatment is primarily a biological process.
Reason (R) : It uses microorganisms to consume dissolved organic pollutants, converting them into biomass and CO_2.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

(c) The Gaussian plume model is for point sources.
(d) An inversion layer enhances dispersion.
(e) Line source models are for highways.
Which of the above statement(s) is/are correct?
(A) (a), (b), (c), (d)
(B) (a), (b), (c), (e)
(C) (a), (c), (d), (e)
(D) (b), (c), (d), (e)

216. What is the primary function of a catalytic converter in a vehicle?
(A) To improve fuel efficiency.
(B) To convert toxic pollutants into less harmful substances.
(C) To muffle engine noise.
(D) To cool the exhaust gases.

217. The Indian standard IS:10500 (2012) relates to the quality of:
(A) Air
(B) Soil
(C) Industrial Effluents
(D) Drinking Water

218. The process of sedimentation is immediately followed by which step in conventional water treatment?
(A) Sand filtration
(B) Chemical coagulation
(C) Final disinfection
(D) Initial flocculation

219. The 'MPN' method is used for the microbiological analysis of water to test for:
(A) Viruses
(B) Algae
(C) Coliform bacteria
(D) Fungi

220. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Parameter)
P. Noise
Q. Radioactivity
R. Turbidity
S. Hardness
List II: (Measurement Unit/Method)
1. NTU
2. mg/L as $CaCO_3$
3. Becquerel (Bq)
4. dB(A)
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-3, R-2, S-1
(D) P-1, Q-2, R-3, S-4

221. Which method is NOT used for the control of gaseous pollutants?
(A) Adsorption
(B) Absorption
(C) Combustion
(D) Centrifugal collection

222. An 'inversion' in the atmosphere refers to a condition where:
(A) Temperature decreases with altitude.
(B) Temperature increases with altitude.
(C) Pressure increases with altitude.
(D) Wind speed is zero.

223. What is the main cause of thermal pollution in water bodies?
(A) Natural sunlight exposure.
(B) Localized geothermal vents.
(C) Discharge of heated water from power plants and industries.
(D) Routine seasonal agricultural runoff.

224. Which of the following is a key biological effect of ionizing radiation?
(A) Increased metabolism.
(B) Improved immune response.
(C) Decreased body temperature.
(D) Damage to DNA and cells.

225. The process of coagulation in water treatment involves:
(A) Adding chemicals to kill bacteria.
(B) Passing water through sand filters.
(C) Adding chemicals like alum to cause small particles to clump together.
(D) Vigorously mixing the water to increase oxygen.

226. What does Leq represent in noise measurement?
(A) THE peak noise level.
(B) The equivalent continuous sound level.
(C) The background noise level.
(D) The level exceeded 10% of the time.

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(D) Texture, structure, and organic components.

205. The primary cause of heat islands in cities is:
(A) The replacement of vegetation with heat-absorbing surfaces like asphalt.
(B) High population density levels.
(C) Excessive use of heaters in winter.
(D) Proximity to large bodies of water.

206. Arrange the following steps in a typical wastewater treatment plant in the correct sequence.
1. Primary Clarifier
2. Bar Screen
3. Aeration Tank
4. Disinfection

(A) 2, 1, 3, 4
(B) 1, 2, 3, 4
(C) 2, 3, 1, 4
(D) 4, 3, 2, 1

207. Which of the following is NOT a criteria air pollutant as defined by many environmental agencies?
(A) Lead
(B) Ozone
(C) Carbon Monoxide
(D) Water Vapor

208. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : For a given water sample, the COD value is typically higher than the BOD value.
Reason (R) : COD measures the oxygen equivalent of chemically oxidizable organic matter, which includes both biodegradable and non-biodegradable substances, whereas BOD only accounts for the biodegradable portion.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

209. The measurement of noise indices like Leq, L10, L90 is done using a:
(A) Seismograph
(B) Sound Level Meter
(C) Anemometer
(D) Spectrophotometer

210. What is the purpose of sedimentation in drinking water treatment?
(A) To allow heavy, flocculated particles to settle out by gravity.
(B) To kill pathogenic microbes chemically.
(C) To remove all dissolved ionic salts.
(D) To adjust the pH to a neutral level.

211. Which of the following is a source of Marine Pollution?
(A) Controlled fishing
(B) Natural coral reef growth
(C) River discharge carrying agricultural runoff
(D) Wave action

212. What does 'TDS' in water quality measurement stand for?
(A) Total Suspended Solids
(B) Total Disinfection Stage
(C) Turbidity Detection System
(D) Total Dissolved Solids

213. Given below are two statements:
Statement I : Industrial effluents can contaminate soil with heavy metals.
Statement II : Soil microorganisms can degrade heavy metals, removing them from the environment.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

214. What are the two main types of sources of air pollutants?
(A) Urban and Rural
(B) Primary and Secondary
(C) Gaseous and Particulate
(D) Natural and Anthropogenic

215. Consider the following statements about air pollution dispersion:
(a) Mixing height is the vertical limit for dispersion.
(b) A positive lapse rate means temperature decreases with height.

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(B) Sunlight reaching the soil surface.
(C) Soil micro-organisms.
(D) The clay content of the soil.

240. The abatement of marine pollution is addressed by:
(A) Increasing coastal development.
(B) Discharging waste further offshore.
(C) Promoting the use of plastic in shipping.
(D) International agreements and national regulations.

241. A major impact of air pollutants like SO_2 and NOx on materials is:
(A) Corrosion and degradation.
(B) Strengthening them.
(C) Cleaning their surfaces.
(D) Making them water-resistant.

242. Arrange the following events in the eutrophication process chronologically.
(a) Algal bloom and death
(b) Oxygen depletion
(c) Nutrient load from runoff
(d) Decomposition of algae by bacteria
Choose the correct sequence:
(A) c, a, d, b
(B) a, c, d, b
(C) c, d, a, b
(D) b, a, c, d

243. The Day-Night Level or LDN, is a noise metric that adds a penalty to sounds that occur:
(A) During the day
(B) On weekends
(C) During rush hour
(D) During the night

244. What is the primary purpose of a Common Effluent Treatment Plant (CETP)?
(A) To treat city sewage.
(B) To treat mixed effluents from a cluster of small industries.
(C) To treat wastewater from a single large industrial plant.
(D) To produce drinking water.

245. In the context of radioactive pollution, which of the following provides the best shielding against gamma rays?
(A) A sheet of paper
(B) A thin sheet of aluminum
(C) Several feet of concrete or lead
(D) The human body

246. Given below are two statements:
Statement I : Soil texture refers to the proportion of sand, silt, and clay.
Statement II : Soil structure refers to how the sand, silt, and clay particles are arranged into aggregates.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

247. THE process of water softening is designed to remove:
(A) Turbidity
(B) Bacteria
(C) Hardness-causing ions like Ca_2+ and Mg_2+
(D) Dissolved oxygen

248. The most significant source of urban air pollution is generally considered to be:
(A) Industrial emissions
(B) Domestic cooking
(C) Natural dust
(D) Vehicular emissions

249. Which of the following is NOT an impact of noise on human health?
(A) Improved cognitive function
(B) Hearing loss
(C) Sleep disturbance
(D) Cardiovascular stress

250. Match the items in List I with the items in List II and select the correct answer using the options given below:
List I: (Concept)
P. Gaussian Plume
Q. BOD
R. Leq
S. Heat Island
List II: (Associated Pollution)
1. Water Pollution
2. Air Pollution
3. Thermal Pollution
4. Noise Pollution
(A) P-2, Q-1, R-4, S-3

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(D) A forest fire.

182. The MPN test is used to estimate the concentration of:
(A) Coliform bacteria.
(B) Heavy metals.
(C) Dissolved oxygen.
(D) Total dissolved solids.

183. Which of the following is an example of an 'active' noise control measure?
(A) Planting trees for sound absorption.
(B) Building a physical noise barrier.
(C) Generating anti-noise to cancel the original noise.
(D) Using sound-absorbing materials on walls.

184. The function of microorganisms in degrading synthetic fertilizers is a form of:
(A) Soil contamination.
(B) Soil sterilization.
(C) Physical weathering.
(D) Bioremediation.

185. Biological effects of ionizing radiations primarily result from:
(A) Heating of tissues.
(B) Depletion of oxygen.
(C) Damage to cellular DNA.
(D) An allergic reaction.

186. Which of the following pollutants is a major cause of acid rain?
(A) Carbon Monoxide
(B) Sulphur Dioxide
(C) Methane
(D) Particulate Matter

187. In a wastewater treatment plant, what is the main purpose of the primary treatment stage?
(A) To remove dissolved organic matter.
(B) To disinfect the water.
(C) To remove nutrients like nitrogen and phosphorus.
(D) To remove large solid objects and grit.

188. Soil structure refers to:
(A) The arrangement of soil particles into aggregates.
(B) The proportion of sand, silt, and clay.
(C) The organic matter content of the soil.
(D) The mineral composition of the soil.

189. Radiation protection principles include all of the following EXCEPT:
(A) Minimizing exposure time.
(B) Maximizing distance from the source.
(C) Concentrating the radioactive source.
(D) Using shielding.

190. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Urban areas are often warmer than surrounding rural areas, a phenomenon known as the heat island effect.
Reason (R) : Urban surfaces like asphalt and concrete absorb more solar radiation, and there is less vegetation for evaporative cooling.
Which of the following options is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

191. Which noise index is defined as the equivalent continuous sound level over a 24-hour period, with a penalty for nighttime noise?
(A) Leq
(B) L10
(C) L90
(D) LDN

192. Which of the following best describes 'tertiary' or 'advanced' wastewater treatment?
(A) THE first stage of treatment that removes large solids.
(B) A polishing stage that removes specific contaminants like nutrients or residual solids.
(C) The biological stage that removes dissolved organics.
(D) The process of sludge digestion.

193. The Gaussian plume model is primarily used for:
(A) Modeling noise from a highway.
(B) Assessing water quality in a river.
(C) Predicting pollutant concentrations from a continuous point source.

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atmosphere, and monitoring stack emissions, which involves measuring pollutants directly from their source, such as an industrial chimney. The principles and instruments used for these two types of measurements differ significantly. For instance, ambient air monitoring might involve high-volume samplers for particulates or continuous analyzers for gases placed at specific locations within a community over extended periods. In contrast, stack emission monitoring often requires isokinetic sampling techniques to ensure the collected sample is representative of the gas stream. In India, the framework for air quality management is guided by the Indian National Ambient Air Quality Standards (NAAQS). These standards prescribe the permissible concentration limits for various criteria pollutants in the ambient air, providing a legal benchmark for assessing air quality and enforcing control measures. The entire monitoring process, from sampling design to instrumental analysis, is foundational for verifying compliance with standards like the NAAQS and for evaluating the effectiveness of pollution control policies.

Based on the above source, attempt the following five questions.

256. What is the primary purpose of the Indian National Ambient Air Quality Standards (NAAQS)?
(A) To specify the instruments required for stack emission monitoring.
(B) To provide legal concentration limits for pollutants in the general outdoor atmosphere.
(C) To dictate the frequency and duration of sampling for all types of pollutants.
(D) To fund research into new pollution control devices.

257. Which of the following statements best differentiates between ambient air monitoring and stack emission monitoring?
(A) Ambient monitoring measures secondary pollutants, while stack monitoring measures primary pollutants.
(B) Ambient monitoring is conducted indoors, while stack monitoring is conducted outdoors.
(C) Ambient monitoring uses only manual methods, while stack monitoring uses only automated instruments.
(D) Ambient monitoring assesses general air quality in an area, while stack monitoring measures pollutants at their direct source of release.

258. The passage implies that the 'period, frequency and duration of sampling' are critical factors for:
(A) Ensuring the collected air quality data is representative and accurate.
(B) Manufacturing pollution control devices.
(C) Determining the biological effects of ionizing radiations.
(D) Calculating the efficiency of a wastewater treatment plant.

259. Based on the context, an 'isokinetic sampling technique' would most likely be used for:
(A) Measuring the pH of a water body.
(B) Analyzing the general air quality of a residential neighborhood.
(C) Measuring particulate matter concentration directly from a factory chimney.
(D) Determining the level of noise pollution near an airport.

260. The relationship between air pollution monitoring and the NAAQS can be described as:
(A) Monitoring provides the data used to assess compliance with the limits set by NAAQS.
(B) The NAAQS determines the cost of monitoring instruments.
(C) The NAAQS only applies to pollutants measured through stack monitoring.
(D) Monitoring is a voluntary activity, whereas NAAQS compliance is mandatory.

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Direction : Please read the following source carefully.

The dispersion of air pollutants in the atmosphere is a complex phenomenon governed by meteorological conditions. A critical concept in this process is the mixing height, or mixing depth, which represents the vertical extent to which pollutants can be dispersed in the lower atmosphere. A low mixing height traps pollutants close to the ground, leading to higher concentrations, while a high mixing height facilitates greater dilution. Atmospheric stability, determined by lapse rates (the rate of temperature change with altitude), also plays a crucial role.

(B) Radioactive pollution
(C) Coastal management
(D) A Heat Island

297. According to the passage, the primary danger associated with radioactive pollution is the:
(A) Biological effect of ionizing radiations on living cells.
(B) Increase in water temperature.
(C) Impact of plastic debris on marine life.
(D) Decrease in dissolved oxygen in urban areas.

298. Which of the following is identified as a source of marine pollution?
(A) The creation of urban heat islands.
(B) Land-based runoff and oil spills.
(C) The biological effects of ionizing radiation.
(D) The use of radiation protection measures.

299. What is a described consequence of thermal pollution in aquatic ecosystems?
(A) The formation of heat islands.
(B) A decrease in dissolved oxygen levels.
(C) An increase in the biological effects of radiation.
(D) The creation of plastic debris.

300. The purpose of radiation standards and protection measures is to:
(A) Limit human exposure to ionizing radiations.
(B) Abate marine pollution.
(C) Manage coastal zones effectively.
(D) Reduce the temperature of industrial discharges.

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of device depends on factors like particle size, required efficiency, and cost.

Based on the above source, attempt the following five questions.

266. Which particulate control device operates on the principle of imparting an electrical charge to particles and then collecting them on oppositely charged surfaces?
(A) Settling chamber
(B) Electrostatic precipitator
(C) Centrifugal collector
(D) Fabric filter

267. A device that uses centrifugal force generated by a spiral gas flow to separate particulate matter is known as a:
(A) Wet collector
(B) Cyclone collector
(C) Settling chamber
(D) Baghouse

268. What is the primary removal mechanism for particulates in a settling chamber?
(A) Gravitational settling
(B) Electrical attraction
(C) Filtration through a fabric medium
(D) Impingement on a liquid surface

269. Based on the passage, which device would be analogous to the functioning of a common household vacuum cleaner?
(A) Electrostatic precipitator
(B) Wet collector
(C) Fabric filter
(D) Settling chamber

270. The passage suggests that the main operational difference between a wet collector and a fabric filter is:
(A) Wet collectors are for large particles, while fabric filters are for gases.
(B) Wet collectors use gravity, while fabric filters use centrifugal force.
(C) Wet collectors charge particles electrically, while fabric filters do not.
(D) Wet collectors use a liquid medium to capture particles, while fabric filters use a solid medium.

Direction : Please read the following source carefully.

Alongside particulate matter, the control of gaseous pollutants is a critical aspect of air quality management. Several key principles are employed for this purpose. Adsorption involves the use of a solid material (adsorbent), such as activated carbon, which has a porous surface that attracts and holds gas molecules. This is distinct from absorption, where the gaseous pollutant is dissolved into a liquid solvent. For example, scrubbers can be used for absorption by passing a gas like sulfur dioxide through a liquid slurry that reacts with it. Another method is condensation, which is effective for vapors that can be converted to a liquid by cooling them or increasing their pressure. This method is often used to recover valuable volatile organic compounds. Combustion, or incineration, is a process that destroys pollutants by oxidizing them at high temperatures, converting them into less harmful substances like carbon dioxide and water. To make this process more efficient and effective at lower temperatures, catalytic combustion can be employed, where a catalyst is used to speed up the oxidation reaction. These methods are vital for controlling emissions from industrial sources. Furthermore, the issue of air quality extends to indoor environments, where indoor air pollution from various sources can pose significant health risks, and to urban settings, where vehicular emissions are a primary contributor to poor urban air quality.

Based on the above source, attempt the following five questions.

271. What is the fundamental difference between adsorption and absorption for controlling gaseous pollutants?
(A) Adsorption uses a liquid to dissolve the gas, while absorption uses a solid to hold it.
(B) Adsorption is a physical process, while absorption is always a chemical reaction.
(C) Adsorption involves a solid adsorbent holding gas molecules, while absorption involves a gas dissolving in a liquid solvent.
(D) Adsorption is used for organic gases, while absorption is used for inorganic gases.

272. The process of using a catalyst to facilitate the oxidation of pollutants at lower temperatures is known as:
(A) Condensation

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Atmospheric stability significantly influences how pollutants spread from their source. A stable atmosphere, often characterized by an inversion or a low lapse rate, restricts vertical air movement and traps pollutants near the ground level. Conversely, unstable conditions with higher lapse rates promote vigorous mixing and rapid dispersion. High wind speeds further assist in diluting concentrations, while mixing height defines the volume available for these dispersion processes.

9. (A) Both Statement I and Statement II are true.
Acid rain is categorized as a secondary pollutant phenomenon because it involves the transformation of primary emissions within the atmosphere. The primary precursors, sulfur dioxide and nitrogen oxides, undergo chemical reactions with water vapor and oxygen to form sulfuric acid and nitric acid. These acidic compounds eventually return to the Earth's surface through precipitation. Both the classification and the specific chemical conversion process are scientifically accurate.

10. (A) P-4, Q-1, R-2, S-3
Different air pollution control devices operate based on distinct physical and electrical principles. Electrostatic precipitators use electrical forces to charge and collect particles, while settling chambers rely on gravitational force. Centrifugal collectors, like cyclones, utilize inertial and centrifugal forces to separate matter from gas. Fabric filters remove particles through mechanisms such as sieving, impaction, and diffusion. Matching these devices with their specific working principles is fundamental.

11. (D) A continuous point source, like a smokestack.
The Gaussian plume model is a standard mathematical tool used to estimate the ground-level concentration of pollutants emitted from a steady, continuous point source. It assumes that the dispersion follows a normal distribution both horizontally and vertically from the centerline of the plume. This model is particularly effective for predicting the environmental impact of industrial smokestacks under various atmospheric stability conditions and varying wind speeds.

12. (B) Adsorption
Adsorption is a surface phenomenon where gas molecules or vapors adhere to the surface of a solid material, known as an adsorbent. This process is widely used in air pollution control to remove volatile organic compounds and odors by passing the contaminated air through materials like activated carbon. Unlike absorption, where the pollutant dissolves into the bulk of a liquid, adsorption is confined to the surface layers.

13. (A) Both A and R are true and R is the correct explanation of A.
During daylight hours, solar radiation heats the Earth's surface, leading to the warming of the adjacent air layer. This creates buoyancy, resulting in unstable atmospheric conditions that facilitate vertical air movement and convective mixing. Consequently, the mixing depth, which is the layer where pollutants are actively dispersed, is much higher during the day. At night, the surface cools, creating stable conditions that reduce vertical mixing.

14. (D) Fabric filtration
Gaseous pollutants are typically controlled through processes such as absorption into liquids, adsorption onto solid surfaces, condensation by cooling, or catalytic combustion. These methods target the molecular nature of gases. In contrast, fabric filtration is a mechanical separation technique specifically designed to capture solid particulate matter or dust. While highly efficient for particles, it is not a primary method for removing gaseous contaminants from air streams.

15. (B) (a), (b) and (c)
Sulfur dioxide is a well-known respiratory irritant that affects the human breathing system. Carbon monoxide poses a health risk by binding with hemoglobin, thereby hindering oxygen transport in the bloodstream. Acid rain results in the chemical weathering of structures composed of marble and limestone. However, it is incorrect to suggest that particulate matter has no impact on plants, as it can block stomata and reduce photosynthesis.

16. (B) The rate of change of temperature with an increase in altitude.
The term lapse rate refers to the specific rate at which the temperature of the atmosphere

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280. What does the Equivalent Continuous Sound Level (Leq) quantify?
(A) The peak noise level recorded during a measurement period.
(B) The average of the highest and lowest noise levels.
(C) The percentage of time a specific noise level is exceeded.
(D) The steady sound level containing the same total acoustic energy as a fluctuating sound.

Direction : Please read the following source carefully.

Assessing water quality is crucial for protecting human, plant, and animal health from the impacts of water pollution. This assessment involves the measurement of a wide array of quality parameters through systematic sampling and analysis. Physical parameters include pH, which indicates acidity or alkalinity; Electrical Conductivity (EC), which measures the water's ability to conduct electricity and is related to the concentration of dissolved ions; turbidity, a measure of water cloudiness caused by suspended particles; and Total Dissolved Solids (TDS). Chemical parameters are extensive, including hardness, determined by calcium and magnesium content; chlorides; and salinity. Key indicators of organic pollution are Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). DO is essential for aquatic life, while BOD measures the oxygen consumed by microorganisms to decompose organic waste, and COD measures the oxygen required to chemically oxidize both organic and inorganic compounds. Nutrient pollution is assessed by measuring nitrates and phosphates, while contamination by toxic substances is checked through analysis of heavy metals and other organic contaminants. For health-related risks, microbiological analysis, such as the Most Probable Number (MPN) method, is used to estimate the concentration of coliform bacteria. The benchmark for safe human consumption in India is provided by the Indian standards for drinking water, specifically IS:10500, 2012.

Based on the above source, attempt the following five questions.

281. A high Biochemical Oxygen Demand (BOD) value in a water sample indicates:
(A) A high level of pollution by biodegradable organic waste.
(B) A low concentration of dissolved oxygen.
(C) A high concentration of heavy metals.
(D) The water is suitable for drinking according to IS:10500, 2012

282. Which parameter is a measure of water cloudiness caused by suspended solids?
(A) pH
(B) Turbidity
(C) Electrical Conductivity (EC)
(D) Hardness

283. The Most Probable Number (MPN) method is specifically used for which type of analysis?
(A) Measuring the concentration of heavy metals.
(B) Estimating the population of indicator bacteria.
(C) Determining the level of Dissolved Oxygen.
(D) Assessing the water's hardness.

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284. According to the passage, the key difference between BOD and COD is that:
(A) BOD measures oxygen demand for biological decomposition, while COD measures oxygen demand for chemical oxidation.
(B) BOD measures nutrients, while COD measures heavy metals.
(C) BOD is a physical parameter, while COD is a chemical parameter.
(D) BOD is relevant for wastewater, while COD is relevant for drinking water.

285. The Indian standard that provides the specifications for drinking water quality is:
(A) The Most Probable Number (MPN) standard.
(B) The standard for measuring BOD and COD.
(C) IS:10500, 2012
(D) The standard for analyzing heavy metals.

Direction : Please read the following source carefully.

The provision of safe drinking water and the management of wastewater are fundamental to public health and environmental protection. Drinking water treatment comprises a sequence of processes designed to remove contaminants. The process typically begins with coagulation

(B) Catalytic combustion
(C) Absorption
(D) Adsorption

273. A factory wants to remove a valuable volatile organic compound from its exhaust stream so it can be reused. Which control method would be most suitable for recovering the compound?
(A) Combustion
(B) Adsorption
(C) Catalytic combustion
(D) Condensation

274. The passage mentions vehicular emissions as a major factor contributing to:
(A) Poor urban air quality
(B) Indoor air pollution
(C) The need for condensation as a control method
(D) The effectiveness of adsorption

275. A scrubber passing sulfur dioxide through a reactive liquid slurry is an application of which control principle?
(A) Adsorption
(B) Condensation
(C) Absorption
(D) Combustion

Direction : Please read the following source carefully.

Noise pollution is a pervasive environmental issue with various sources, ranging from industrial machinery to transportation systems. The measurement of noise is complex and involves weighting networks to adjust sound level readings to better reflect the human ear's response. For instance, the A-weighting network is commonly used as it mimics human hearing at low to moderate sound levels. To quantify fluctuating noise levels over time, several noise indices are used. The Equivalent Continuous Sound Level (Leq) represents the steady sound level that would contain the same amount of acoustic energy as the fluctuating sound over the same period. Percentile-derived indices like L10, L50, and L90 represent the sound levels exceeded for 10%, 50%, and 90% of the measurement time, respectively; L90 is often used to indicate background noise. Other specific indices include the Day-Night Average Sound Level (LDN), which applies a penalty to nighttime noise, and the Traffic Noise Index (TNI). The concept of noise dose quantifies an individual's total exposure to noise over a workday. To mitigate this issue, noise pollution standards set permissible limits. Control and abatement measures are categorized as active, which involve introducing a secondary sound source to cancel the primary noise, or passive, which involve blocking or absorbing sound using barriers or insulation.

Based on the above source, attempt the following five questions.

276. Which noise index represents the sound level that is exceeded for 90% of the measurement duration and is often used to describe background noise?
(A) L90
(B) Leq
(C) L10
(D) L50

277. According to the passage, the primary purpose of using weighting networks in noise measurement is to:
(A) Increase the measured sound level to a higher value.
(B) Separate industrial noise from traffic noise.
(C) Calculate the Traffic Noise Index (TNI).
(D) Adjust the measurement to better align with human auditory perception.

278. Installing a sound-insulating barrier along a highway to protect a residential area is an example of which type of noise control measure?
(A) An active method
(B) A passive method
(C) A weighting network
(D) A noise dose calculation

279. The Day-Night Average Sound Level (LDN) is distinct from other indices like Leq because it:
(A) Is only used for reaching traffic noise.
(B) Measures the sound level exceeded for 50% of the time.
(C) Incorporates a penalty for noise occurring during nighttime hours.
(D) Represents the total noise exposure for a single worker.

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a capacity for self-purification, largely driven by soil micro-organisms. These microbes play essential functions in nutrient cycling and the degradation of certain pollutants. For instance, specific microbial populations are capable of breaking down complex organic molecules found in pesticides and synthetic fertilizers, a process crucial for bioremediation and mitigating the long-term impacts of agricultural and industrial pollution on soil quality.

Based on the above source, attempt the following five questions.

291. Soil texture is defined by the:
(A) Arrangement of soil particles into aggregates.
(B) Amount of organic matter present in the soil.
(C) Relative proportions of sand, silt, and clay.
(D) Presence of industrial effluents.

292. According to the passage, the degradation of pesticides and synthetic fertilizers in soil is primarily carried out by:
(A) Soil micro-organisms.
(B) The inorganic components of the soil.
(C) The physical process of aggregation.
(D) The chemical interaction with industrial effluents.

293. What is the relationship between soil texture and soil structure?
(A) They are identical terms for the same property.
(B) Texture is a biological property, while structure is a chemical property.
(C) Texture relates to organic components, while structure relates to inorganic components.
(D) Texture refers to particle size composition, while structure refers to the arrangement of those particles.

294. The passage suggests that industrial effluents can cause soil pollution by:
(A) Enhancing the function of soil micro-organisms.
(B) Interacting with and altering the soil's natural components.
(C) Increasing the proportion of soil organic matter.
(D) Improving the soil's texture and structure.

295. The role of organic components in soil is described as being crucial for:
(A) Determining the proportion of sand and silt.
(B) Forming the inorganic mineral base of the soil.
(C) Maintaining soil fertility and health.
(D) The immediate degradation of industrial effluents.

Direction : Please read the following source carefully.

Beyond air, water, and soil pollution, several other forms of environmental degradation pose significant threats. Thermal pollution, primarily from industrial cooling processes and power plants, involves the discharge of heated water into aquatic ecosystems, which can alter species composition and decrease dissolved oxygen levels. A related urban phenomenon is the creation of Heat Islands, where metropolitan areas are significantly warmer than their surrounding rural areas due to heat absorbed by buildings and pavement and waste heat from human activities. Marine pollution is a global issue with sources including land-based runoff, oil spills, and plastic debris, which have severe impacts on marine biodiversity and ecosystems. Methods of abatement for marine pollution are diverse, ranging from controlling land-based sources to cleanup operations for spills. Effective coastal management strategies are essential to protect these fragile and valuable zones. Another distinct and hazardous form of pollution is radioactive pollution, originating from sources like nuclear power plants, medical applications, and nuclear weapons testing. The primary danger lies in the biological effects of ionizing radiations, which can damage DNA and cause severe health problems. Exposure is measured in specific units, and radiation standards are established to limit public and occupational exposure. Consequently, radiation protection measures, including shielding, distance, and limited exposure time, are critically important to minimize risk.

Based on the above source, attempt the following five questions.

296. The phenomenon where a metropolitan area is significantly warmer than its surrounding rural areas is known as:
(A) Thermal pollution

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and flocculation, where chemicals are added to cause small suspended particles to clump together into larger, heavier flocs. This is followed by sedimentation, where these flocs settle out of the water by gravity in a clarification tank. The water then undergoes filtration, often through layers of sand and gravel, to remove any remaining suspended particles. The final and most critical step for health protection is disinfection, commonly achieved using chlorine, to kill or inactivate pathogenic microorganisms. In areas with hard water, a softening process may also be included to reduce the concentration of calcium and magnesium ions. On the other side of the water cycle, wastewater treatment is generally categorized into three stages. Primary treatment is a physical process involving screening and sedimentation to remove large solids and suspended matter. Secondary treatment is a biological process that uses microorganisms to break down dissolved organic matter. Advanced (or tertiary) treatment involves further processes to remove specific pollutants like nutrients (nitrates, phosphates) or residual contaminants before the water is discharged or reused.

Based on the above source, attempt the following five questions.

286. In drinking water treatment, what is the primary purpose of the coagulation and flocculation stage?
(A) To kill pathogenic microorganisms.
(B) To remove large solid objects like rags and sticks.
(C) To reduce the concentration of dissolved calcium and magnesium.
(D) To cause small suspended particles to aggregate into larger flocs.

287. Which stage of wastewater treatment is primarily biological in nature and focuses on removing dissolved organic matter?
(A) Primary treatment
(B) Advanced treatment
(C) Secondary treatment
(D) Sedimentation

288. The process of passing water through layers of sand and gravel to remove suspended particles is known as:
(A) Disinfection
(B) Filtration
(C) Flocculation
(D) Sedimentation

289. What is the key difference between primary and secondary wastewater treatment as described in the passage?
(A) Primary treatment is biological, while secondary treatment is physical.
(B) Primary treatment removes dissolved organics, while secondary treatment removes large solids.
(C) Primary treatment disinfects the water, while secondary treatment softens it.
(D) Primary treatment is a physical process for solids removal, while secondary treatment is a biological process for dissolved organics.

290. Advanced wastewater treatment is employed to:
(A) Remove specific pollutants like nutrients after the secondary stage.
(B) Remove large solids and grit at the beginning of the process.
(C) Settle out the flocs created during coagulation.
(D) Disinfect drinking water using chlorine.

Direction : Please read the following source carefully.

Soil, a vital environmental medium, possesses a complex array of physico-chemical and biological properties that determine its quality and function. Key physical properties include soil texture, which refers to the relative proportions of sand, silt, and clay particles, and soil structure, which describes the arrangement of these particles into aggregates. These properties influence water retention, aeration, and root penetration. The chemical properties are governed by both inorganic and organic components. Inorganic components include minerals and various ions that determine the soil's nutrient status and pH, while organic components, derived from decomposed plant and animal matter, form soil organic matter, which is crucial for fertility and soil health. Soil pollution occurs when industrial effluents and other contaminants interact with these soil components, altering their natural balance. The introduction of harmful chemicals can disrupt the soil's physico-chemical properties and harm the soil biota. However, the soil also possesses

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ANSWERS

1. (B) Carbon monoxide
Primary pollutants are emitted directly from sources like vehicles or industrial processes. Carbon monoxide is a byproduct of incomplete combustion in automobile engines and is released directly into the atmosphere without needing chemical transformation. In contrast, secondary pollutants like ozone are formed through atmospheric reactions. Understanding the origin of pollutants is crucial for environmental monitoring and implementing effective emission control strategies for protecting public health.

2. (A) They are formed in the atmosphere through chemical reactions of primary pollutants.
Secondary pollutants originate from chemical interactions between primary pollutants and natural atmospheric components, often catalyzed by sunlight. These substances are not released directly from industrial stacks or vehicle exhausts but develop over time as precursors react. Examples include photochemical oxidants and certain acids. Identifying these pollutants is essential for air quality management because their control requires reducing emissions of their primary precursor gases in urban areas.

3. (C) Fossil fuel combustion
Anthropogenic sources of pollution result specifically from human activities rather than natural geological or biological events. The combustion of fossil fuels in power plants, industrial boilers, and motor vehicles represents a significant human-driven source of atmospheric contaminants. While events like volcanic eruptions and forest fires release similar pollutants, they are categorized as natural sources. Distinguishing between these sources helps in drafting targeted environmental regulations.

4. (D) Photochemical oxidants
Photochemical oxidants are a category of secondary pollutants created when nitrogen oxides and volatile organic compounds react in the presence of solar radiation. This complex series of atmospheric chemical reactions leads to the formation of substances like ozone and peroxyacetyl nitrate. These pollutants are key components of urban smog and can cause respiratory issues and damage to vegetation. Monitoring these substances is vital for assessing urban air quality.

5. (C) Carbon Dioxide
Criteria air pollutants are specific atmospheric contaminants for which regulatory agencies establish health-based standards to protect public welfare. Common examples include lead, nitrogen dioxide, carbon monoxide, and sulfur dioxide. While carbon dioxide is a significant greenhouse gas involved in climate change, it is traditionally not listed among the primary criteria pollutants regulated for direct toxicity and immediate health impacts in ambient air quality standards.

6. (B) Total time over which a single sample is collected.
In environmental monitoring, the period of sampling refers to the specific duration during which an air sample is continuously drawn into a collection device. This timeframe ensures that the data reflects representative pollutant levels over a set interval, such as eight or twenty-four hours. Accurate sampling periods are necessary to compare results with established ambient air quality standards and to identify trends in pollution.

7. (D) Gravitational settling
Gravitational settling is the fundamental mechanism utilized in a settling chamber to remove large particulate matter from industrial gas streams. As the velocity of the gas is significantly reduced upon entering the chamber, the force of gravity causes heavier particles to fall out of the stream into collection hoppers. This method is most effective for coarse particles and serves as a preliminary treatment before finer filtration.

8. (A) A stable atmosphere with a negative lapse rate enhances pollutant dispersion.

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To predict pollutant concentrations downwind from a source, various mathematical models are employed. The Gaussian plume model is a widely used approach for estimating concentrations from a point source, such as a single smokestack, assuming a normal (Gaussian) distribution of pollutants in both horizontal and vertical directions. For different source geometries, other models are used; the line source model is applied to sources like highways with continuous vehicular emissions, while the area source model is suitable for diffuse sources such as an entire urban or industrial complex. The impact of pollutants, once dispersed, is significant, affecting human health, causing damage to plants, and deteriorating materials. A major environmental consequence is acid rain, which forms when pollutants like sulfur dioxide and nitrogen oxides react in the atmosphere and return to Earth as acidic precipitation.

Based on the above source, attempt the following five questions.

261. According to the passage, a low mixing depth combined with stable atmospheric conditions would likely result in:
(A) The rapid formation of acid rain.
(B) Decreased pollutant concentrations at ground level.
(C) Greater dispersion of pollutants over a wide area.
(D) Increased pollutant concentrations near the source.

262. Which dispersion model would be most appropriate for predicting air pollutant concentrations from a continuous stream of traffic on a busy freeway?
(A) Gaussian plume model
(B) Line source model
(C) Area source model
(D) Point source model

263. The passage defines the 'mixing height' as:
(A) The altitude at which acid rain is formed.
(B) The vertical distance pollutants travel before becoming harmless.
(C) The vertical layer of the atmosphere available for pollutant dispersion.
(D) The rate of temperature change with altitude.

264. What is the relationship between lapse rates and pollutant dispersion as implied in the text?
(A) Lapse rates directly determine the chemical composition of acid rain.
(B) Lapse rates are a component of the Gaussian plume model but not other models.
(C) Higher lapse rates always lead to lower pollutant concentrations.
(D) Lapse rates influence atmospheric stability, which in turn affects how pollutants disperse.

265. Acid rain is presented in the passage as a consequence of:
(A) Atmospheric chemical reactions involving pollutants like SO_2 and NOx.
(B) Pollutants being trapped below the mixing height.
(C) The application of the area source dispersion model.
(D) The deterioration of materials due to primary pollutants.

Direction : Please read the following source carefully.

Controlling air pollution involves the use of specific technologies designed to capture pollutants before they enter the atmosphere. For particulate matter, a range of control devices is available, each operating on different principles. The settling chamber is one of the simplest devices, relying on gravity to remove larger particles as the gas stream's velocity is reduced. For finer particles, centrifugal collectors, such as cyclones, use centrifugal force to separate particulates from the gas. In this device, the gas is forced into a spiral flow, causing heavier particles to move outward and strike the collector wall, from which they are collected at the bottom. Wet collectors, or scrubbers, capture particles by bringing the polluted gas stream into contact with a liquid, typically water. A more advanced and highly efficient method involves fabric filters, commonly known as baghouses, which operate like a vacuum cleaner, trapping particles on the surface of fabric bags as the air passes through. For very fine particles, the electrostatic precipitator (ESP) is extremely effective. It works by charging the particles in the gas stream with an electric field, then collecting these charged particles on plates with an opposite electrical charge. The choice

decreases or increases with a change in height. It is a fundamental concept in meteorology and environmental science used to determine atmospheric stability. A standard lapse rate indicates cooling with altitude, whereas an inversion occurs when temperature increases with height. Understanding these rates is essential for predicting the dispersion of pollutants.

17. (B) A busy highway.
A line source model is an analytical approach used to calculate the concentration of pollutants originating from linear emitters. This is most appropriately applied to busy highways, where a continuous stream of vehicles acts as a single, elongated source of emissions. Unlike point sources such as chimneys, line sources require different mathematical treatments to account for the horizontal distribution of contaminants along the path of road.

18. (A) Inertia and centrifugal force acting on particles.
Cyclone separators function by converting the velocity of an incoming gas stream into a high-speed rotational flow within a cylindrical chamber. This rotation creates powerful centrifugal forces that drive heavier particles toward the outer walls. Due to their inertia, these particles strike the walls and slide down into a hopper, while the cleaned gas exits through the center. This mechanical process requires no moving parts.

19. (C) Adsorption and absorption
Controlling gaseous pollutants effectively often involves the use of adsorption and absorption processes. Absorption involves the transfer of gas molecules into a liquid solvent where they dissolve. Adsorption involves the accumulation of gas molecules on the surface of solid materials such as activated carbon. Other methods like settling and filtration are primarily designed for particulate matter and are not suitable for removing gases.

20. (B) b, d, c, a
The standard process for treating drinking water follows a specific chronological order to ensure safety and clarity. Initially, coagulation and flocculation are performed to aggregate fine particles. This is followed by sedimentation, where the larger flocs are allowed to settle by gravity. The water then undergoes filtration to remove any remaining suspended matter. Finally, disinfection is carried out to eliminate pathogenic microorganisms before distribution.

21. (C) L90
The L90 index is a statistical parameter used in acoustics to represent the sound pressure level that is exceeded for ninety percent of the total monitoring time. Because it excludes short-duration, loud events, it is widely considered an accurate measure of the underlying background or residual noise in a given environment. This metric is essential for assessing the baseline acoustic conditions of residential, commercial, or industrial areas.

22. (B) Frequency response of the human ear at low to moderate sound levels.
The A-weighting network is a frequency filter used in sound level meters to adjust recorded noise measurements to better reflect human hearing. Since the human ear is less sensitive to very low and very high frequencies at moderate loudness, this network attenuates those parts of the spectrum. It provides a single value in decibels, known as dB(A), which correlates closely with perceived loudness.

23. (D) L90 - The sound level exceeded 90% of the time, representing the average noise.
While L90 correctly identifies the sound level exceeded for ninety percent of the measurement period, it does not represent the average noise level. Instead, L90 is specifically used to characterize the constant background or baseline noise of an area. The average noise level over time is more accurately described by Leq, the equivalent continuous sound level. Understanding these statistical differences is critical for assessment.

24. (A) Both A and R are true and R is the correct explanation of A.
Active noise control utilizes electronic systems to generate sound waves that are identical in amplitude but exactly opposite in phase to the offending noise. This process, known as destructive interference, effectively cancels out the original sound. This technique is particularly successful for low-frequency noises because

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reflect this, the calculation includes a ten-decibel penalty added to sound levels measured during the nighttime period, typically from ten in the evening until seven in the morning. This weighted average provides a more accurate assessment.

94. (D) To remove fine suspended particles and flocs that did not settle out.
Filtration is a critical step in the drinking water treatment process that follows sedimentation. Its primary role is to capture fine suspended matter, colloidal particles, and any remaining flocs that were not removed in the settling basin. By passing water through sand or gravel, clarity is significantly improved. This process ensures the removal of physical impurities and some microorganisms.

95. (D) (a), (b), (c), and (d)
Soil texture is defined by the proportions of sand, silt, and clay, while structure describes the arrangement of these particles into aggregates. The inorganic components of soil originate from geological weathering of parent rock material. Organic components consist of both living organisms and decaying biological matter. All these factors interact to determine the physical, chemical, and biological health of soil ecosystems.

96. (B) The process of being exposed to ionizing radiation.
Radiation exposure is the condition of being subjected to ionizing radiation from an external source or internal contamination. This process involves the interaction of high-energy rays or particles with matter, which can lead to various physical and biological changes. It is a fundamental concept in radiological health used to quantify risk to humans. Distinguishing between exposure and dose is critical.

97. (D) BOD measures only biodegradable organics, while COD measures nearly all oxidizable compounds.
Biological Oxygen Demand and Chemical Oxygen Demand both assess organic strength, but they use different methods. BOD specifically measures the oxygen required by microbes to break down biodegradable matter over time. In contrast, COD uses a strong chemical oxidant to measure nearly all organic and inorganic compounds. Consequently, COD values are almost always higher because they include resistant substances.

98. (A) Using an electronic system to generate 'anti-noise'.
Active noise control is a modern technique that uses electronic components to mitigate unwanted sound. The system captures offending noise with a microphone and generates a secondary sound wave that is the exact inverse of the original. When these waves meet, destructive interference occurs, effectively canceling the noise. This is considered an active method because it requires power and a control system.

99. (C) Strong inversion (stable)
Fanning occurs when a pollutant plume is emitted into a highly stable atmosphere, typically during a strong temperature inversion. Under these conditions, vertical air movement is severely restricted, but horizontal wind remains present. As a result, the plume spreads out into a thin, horizontal sheet that drifts downwind with very little vertical mixing. This transports pollutants over very long distances.

100. (B) P-2, Q-1, R-4, S-3
Hardness in water is primarily caused by dissolved calcium and magnesium ions. Turbidity is an indicator of the presence of suspended or colloidal matter that scatters light. High chloride levels can signify sewage pollution or the intrusion of saline water. Nitrates are often associated with fertilizer runoff from agriculture or contamination from sewage. Correctly identifying these parameters is essential for water quality.

101. (D) They can be leached into groundwater and cause nitrate pollution.
While synthetic fertilizers increase crop yields, they pose significant environmental risks. Excess nitrogen from these fertilizers can be washed out of the soil by rain or irrigation water. This leaching process transports nitrates into underlying aquifers, contaminating groundwater supplies. High nitrate levels in drinking water are a health concern, particularly for infants. This highlights the need for sustainable agricultural management.

102. (B) Increasing the intensity of the radiation source.

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suspended particles and colloidal matter. This allows the particles to aggregate into larger, heavier clumps known as flocs. These flocs can then be easily removed through sedimentation.

34. (A) Sedimentation
Sedimentation is a physical water treatment process that utilizes gravity to remove suspended solids from water. After the particles have been aggregated into larger flocs during coagulation and flocculation, the water enters a quiet basin where the flow velocity is reduced. This allows the heavier flocs to settle to the bottom as sludge. This step significantly reduces the turbidity before the final filtration stage.

35. (A) P-2, Q-3, R-4, S-1
Each stage of water treatment serves a specific goal to ensure overall quality. Disinfection is used to kill or inactivate pathogenic microorganisms. Flocculation facilitates the agglomeration of small particles into larger flocs for easier removal. Filtration is the process of removing fine suspended solids by passing water through porous media. Softening specifically targets the removal of hardness caused by calcium and magnesium ions.

36. (D) Primary treatment
Primary treatment is the initial stage of wastewater processing that relies almost exclusively on physical mechanisms to remove pollutants. This phase involves screening to capture large floating objects and grit removal to protect equipment from abrasion. Subsequently, sedimentation tanks allow heavier organic and inorganic solids to settle out of the liquid. This stage effectively reduces the suspended solids load before complex treatment.

37. (C) Dissolved organic matter (BOD)
The central goal of secondary wastewater treatment is the reduction of dissolved and colloidal organic matter that remains after primary treatment. This is achieved through biological processes where aerobic or anaerobic microorganisms consume the organic material as a food source. By breaking down these substances, the Biological Oxygen Demand of the effluent is significantly lowered. This protects receiving water bodies from oxygen depletion.

38. (A) Both Statement I and Statement II are true.
The activated sludge process is a fundamental method used in secondary wastewater treatment facilities worldwide. It utilizes a concentrated mass of aerobic microorganisms, known as activated sludge, to stabilize organic matter in an aeration tank. These microbes require a continuous supply of oxygen to efficiently break down pollutants. Both the classification of the process and its reliance on aerobic biological activity are accurate descriptions.

39. (D) Treat combined wastewater from a cluster of small-scale industrial units.
A Common Effluent Treatment Plant is a centralized facility designed to treat the collective wastewater generated by several small and medium-scale industrial units located within a specific cluster or estate. This collaborative approach allows individual businesses to meet environmental standards without the high cost of separate systems. By pooling resources, these plants achieve better efficiency and more consistent monitoring of pollutants.

40. (A) Both A and R are true and R is the correct explanation of A.
A high Biological Oxygen Demand value serves as a clear indicator of significant organic pollution within a water body. When large amounts of organic waste are present, indigenous microorganisms consume dissolved oxygen at an accelerated rate to decompose the matter. This rapid consumption can deplete the oxygen levels to the point where fish and other aquatic organisms cannot survive. Therefore, BOD measurement is essential.

41. (C) pH
The primary physico-chemical properties of soil include its texture, structure, and the various inorganic and organic components that form its bulk. These characteristics define the physical environment and chemical makeup of the soil matrix. While pH is a vital chemical property used for assessment, it is often considered a secondary or derived measure of the soil chemical state rather than a fundamental physical constituent.

42. (A) Sand, silt, and clay
Soil texture is defined by the relative percentages of sand, silt, and clay particles present in

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The accumulation of phosphates and nitrates in water bodies often leads to eutrophication, a process characterized by excessive nutrient enrichment. These chemicals act as fertilizers that stimulate the rapid growth of algae, leading to thick algal blooms. When these algae die and decompose, they consume vast amounts of dissolved oxygen, which can severely harm aquatic life. The link between nutrient presence and degradation is sound.

60. (A) Pollutant gas dissolves in a liquid solvent.
Absorption is a fundamental chemical engineering process where a gaseous pollutant is removed from a gas stream by dissolving it into a liquid solvent. This occurs through a mass transfer process where the gas molecules migrate into the bulk of the liquid phase. It is widely used in industrial scrubbers to control emissions of soluble gases like sulfur dioxide from exhaust streams.

61. (B) P-3, Q-2, R-4, S-1
Carbon monoxide impacts health by reducing the oxygen-carrying capacity of the blood. Sulfur dioxide is a known respiratory irritant that can cause bronchoconstriction. Fine particulate matter can penetrate deep into the lungs and cause cardiovascular issues. Lead exposure is particularly dangerous as it can lead to permanent neurological and developmental damage, especially in children. Correctly matching these pollutants to their effects is vital.

62. (B) The annoyance caused by fluctuating traffic noise.
The Traffic Noise Index is a specialized acoustic metric designed to quantify the degree of annoyance experienced by people exposed to variable traffic noise. It takes into account both the average sound level and the degree of fluctuation between the peak and background levels. By incorporating these variations, the index provides a more accurate reflection of human psychological response to road noise.

63. (C) Advanced treatment
Advanced wastewater treatment, often referred to as tertiary treatment, includes specialized processes specifically designed to remove pollutants that remain after secondary biological treatment. A primary focus of this stage is the removal of nutrients like nitrogen and phosphorus, which can cause eutrophication in receiving water bodies. Techniques such as chemical precipitation and ion exchange are employed to achieve high-quality effluent discharge.

64. (D) To neutralize and destabilize colloidal particles, allowing them to clump together.
In drinking water treatment, coagulants like alum are added to neutralize the electrical charges that keep small colloidal particles repelling each other. By destabilizing these particles, the chemicals allow them to collide and stick together, forming larger masses. This process is essential because these fine particles are too small to settle by gravity. Once aggregated, they can be efficiently removed through sedimentation.

65. (B) (b) and (c) only
Anthropogenic sources of pollution are those that originate specifically from human activities. Industrial smokestacks and vehicle exhausts are classic examples, as they result from manufacturing and transportation. Conversely, volcanic eruptions and forest fires are natural events, even though they release significant pollutants. While animal respiration involves biological life, it is a natural metabolic process rather than a human-induced pollutant source for regulations.

66. (B) Structure
Soil structure refers to the physical arrangement and organization of individual soil particles into larger, distinct units called aggregates or peds. This characteristic is different from texture, which describes the proportion of various particle sizes. A well-developed structure is vital for soil health because it creates pores that facilitate the movement of air and water and supports root growth in plants.

67. (D) (a), (b), (c), and (d)
The biological consequences of exposure to ionizing radiation depend on several critical factors. These include the total dose of radiation absorbed, the specific type of radiation involved, such as alpha or gamma, and the duration of the exposure event. Additionally, the sensitivity of the specific body tissues exposed plays a major

settle. This is followed by biological treatment, such as the activated sludge process, which targets dissolved organic matter. Finally, the collected solids undergo sludge digestion for stabilization and safety.

51. (D) The damage to molecules, particularly DNA, within cells.
Ionizing radiation possesses sufficient energy to displace electrons from atoms, creating highly reactive ions and free radicals. When this occurs within living tissues, these reactive species can directly or indirectly damage vital molecules, most notably DNA. This cellular damage can lead to mutations, cell death, or the development of cancer over time. Understanding this fundamental biological interaction is key to safety protocols.

52. (B) Charging particles and then collecting them on an oppositely charged surface.
An electrostatic precipitator is a highly efficient filtration device used to remove fine particles from flowing gases. It works by passing the gas through a high-voltage corona where the particles receive a negative electrical charge. These charged particles are then attracted to and captured by positively charged collection plates. Periodically, the plates are vibrated or washed to remove the accumulated dust for discharge.

53. (D) Outdoor air in the general environment.
In the context of the National Ambient Air Quality Standards, the term ambient refers to the outdoor air that surrounds us in the general environment. These standards do not apply to the air inside private residences, commercial buildings, or industrial workplaces, which are governed by different rules. Monitoring ambient air quality is crucial for protecting the health of the general public and regional ecosystems.

54. (A) Condensation
Condensation is a process used in air pollution control to remove gaseous pollutants that have relatively high boiling points. By significantly cooling the gas stream or increasing the pressure, the pollutants undergo a phase change from gas to a liquid state. The resulting liquid can then be collected and either disposed of or recycled. This method is particularly effective for recovering valuable solvents.

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55. (A) Both Statement I and Statement II are true.
In urban environments, vehicular emissions represent a primary source of air contaminants, including carbon monoxide and nitrogen oxides. To mitigate this impact, modern vehicles are equipped with catalytic converters. These devices facilitate chemical reactions that transform toxic carbon monoxide, nitrogen oxides, and unburned hydrocarbons into less harmful substances like carbon dioxide, nitrogen, and water vapor. Both source identification and technology function are correct.

56. (A) (a), (b), and (c)
Wet collectors, or scrubbers, effectively use liquid sprays to remove both particles and certain gases. Fabric filters are known for their exceptional efficiency in capturing very fine particulate matter. Settling chambers are simple devices best suited for removing large, heavy particles through gravity. However, electrostatic precipitators are primarily designed for particulate removal rather than gaseous pollutants, making the final statement inaccurate in context.

57. (B) A residential area with many small chimneys from heating.
An area source model is designed to represent the collective emissions from a large number of small, diffuse sources spread over a defined geographic region. A typical application is modeling the cumulative impact of many residential chimneys used for home heating in a neighborhood. Unlike point sources like large industrial stacks or line sources like highways, area sources are treated as diffuse emitters.

58. (A) DO - Measured using the Winkler method or a DO probe
Dissolved oxygen is a critical parameter for aquatic life and is accurately measured using the classical Winkler titration method or modern electronic DO probes. Other pairs mentioned are incorrect because turbidity is measured using light-scattering techniques rather than pH meters. Furthermore, water hardness is primarily caused by calcium and magnesium ions rather than chlorides. Finally, pH is determined using meters or indicators.

59. (A) Both A and R are true and R is the correct explanation of A.

the mineral fraction of the soil. These three components are distinguished by their size, with sand being the coarsest and clay being the finest. The specific proportion of these particles determines how well the soil retains water, its aeration capacity, and its overall suitability for different types of vegetation.

43. (D) Degradation of pesticides and synthetic fertilizers
Soil micro-organisms play a critical role in maintaining environmental health by breaking down complex chemical compounds. They are primarily responsible for the biological degradation of synthetic fertilizers and pesticides that accumulate in the ground. This process helps detoxify the soil and recycle nutrients into forms that plants can readily absorb. Without these microbes, persistent chemical pollutants would pose a much greater risk to ecosystems.

44. (B) Altering soil pH and introducing heavy metals.
When industrial effluents are discharged onto land, they can significantly alter the soil natural chemistry. These liquids often have extreme pH values, which can disrupt the balance of the soil ecosystem and affect plant growth. Additionally, many industrial processes release heavy metals that can accumulate in the soil matrix. These contaminants pose long-term risks as they can eventually enter the human food chain.

45. (B) (c) and (e) only
Industrial effluents are a well-documented source of heavy metal contamination in soils. Furthermore, a comprehensive analysis of soil quality must involve the assessment of its physico-chemical and biological properties to understand its health. However, texture describes particle proportions rather than arrangement, and structure is not determined solely by sand percentages. Additionally, the degradation of fertilizers is not always purely beneficial for ecosystems.

46. (D) Biological process mediated by micro-organisms
The breakdown of pesticides in the soil environment is predominantly a biological process. Soil-dwelling micro-organisms, including various species of bacteria and fungi, utilize these chemical compounds as a source of energy or nutrients. This microbial metabolism transforms complex, often toxic, molecules into simpler and less harmful substances. While physical and chemical factors influence the rate, the primary mechanism for removal is biological activity.

47. (A) The replacement of natural surfaces with heat-absorbing materials like asphalt and concrete.
The urban heat island effect occurs because cities replace natural landscapes, such as forests and grasslands, with dense infrastructure. Materials like asphalt and concrete have a high thermal mass and low albedo, meaning they absorb and retain significant amounts of solar radiation during the day. This trapped heat is slowly released at night, keeping urban centers much warmer than the surrounding rural areas.

48. (B) Cold water release from the base of a dam.
Thermal pollution typically involves the unnatural increase in water temperature from sources like power plant cooling systems and industrial effluent discharge. Even deforestation contributes by increasing solar exposure. However, the release of deep, cold water from the base of a dam represents a decrease in temperature. While this still disrupts the local ecosystem, it is not categorized as typical warming associated with thermal pollution.

49. (C) Oil spills and offshore drilling
Marine environments are highly susceptible to pollution from offshore industrial activities. Oil spills, whether resulting from tanker accidents or leaks during offshore drilling operations, introduce vast quantities of hydrocarbons into the ocean. These substances can coat marine life, disrupt ecological balances, and persist in the environment for many years. Addressing these risks requires stringent international regulations and advanced response technologies to minimize oceanic impacts.

50. (A) b, d, c, a
Effective wastewater treatment involves a series of logical steps to remove different types of contaminants. The process begins with screening and grit removal to eliminate large debris. Next, primary sedimentation allows heavier solids to

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role in determining impact severity. All these parameters must be considered.

68. (A) Potential for structural damage and human annoyance.
Monitoring ground and structural vibrations is essential for maintaining safety and comfort in built environments. Excessive vibrations from construction, industrial machinery, or transportation can lead to the development of cracks and long-term structural fatigue in buildings. Furthermore, even at lower intensities, vibrations can cause significant annoyance and stress to people. Assessing these levels is a key component of environmental impact studies.

69. (C) Increased growth of beneficial cold-water fish species.
Thermal pollution in aquatic ecosystems leads to several negative impacts, such as reduced dissolved oxygen levels and increased metabolic rates that force organisms to consume more energy. Sudden temperature changes can also cause lethal thermal shock. However, warming typically harms cold-water species rather than promoting their growth. Instead, such conditions often favor the proliferation of less desirable warm-water species in ecosystems.

70. (A) a, b, d, c
Particulate control devices vary significantly in their ability to capture fine matter. Settling chambers are the least efficient, working mainly on large particles. Centrifugal collectors offer better performance but are still limited for very fine dust. Electrostatic precipitators provide much higher efficiency for sub-micron particles. Finally, fabric filters are often considered the most effective for capturing the finest particles in industrial engineering.

71. (D) Balance environmental, economic, and social demands on the coastal zone.
Coastal management is a multi-disciplinary approach aimed at the sustainable use of shorelines. It seeks to harmonize the often-conflicting demands of environmental protection, economic development, and social needs. By protecting sensitive ecosystems like mangroves while allowing for regulated tourism and industry, this practice ensures long-term viability. It involves planning for sea-level rise and preventing erosion to maintain region health.

72. (B) Total Dissolved Solids (TDS)
Total Dissolved Solids represents the combined content of all inorganic and organic substances present in a liquid in molecular, ionized, or micro-granular form. In water quality analysis, it is measured by filtering a sample to remove suspended matter and then evaporating the liquid to dryness. The remaining solid residue is weighed to determine the TDS concentration. This parameter indicates mineralization.

73. (A) Both A and R are true and R is the correct explanation of A.
In an unstable atmosphere, the actual lapse rate is greater than the dry adiabatic lapse rate, a condition known as super-adiabatic. This state promotes the rapid vertical rising of air parcels, leading to vigorous convective mixing. As a result, pollutants emitted into such an environment are quickly transported upwards and dispersed, preventing high concentrations. Therefore, atmospheric instability is generally favorable for dispersion.

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74. (D) Bioremediation
Bioremediation is an environmental technology that utilizes the natural metabolic processes of microorganisms to clean up contaminated soil and water. By introducing or stimulating specific bacteria and fungi, complex pollutants like synthetic fertilizers and pesticides can be broken down into simpler, non-toxic substances. This approach is often more cost-effective and less invasive than traditional physical cleanup methods for restoring ecosystems.

75. (A) 50% of the measurement time, often considered the median noise level.
The L50 noise index is a statistical measure that identifies the sound pressure level that is exceeded for exactly fifty percent of a specific monitoring period. It serves as the median noise level, providing a balanced view of the acoustic environment by accounting for both higher and lower sounds. This metric is useful in urban noise studies to understand typical sound conditions.

76. (B) To quantify the rate and concentration of pollutants being discharged from a specific source.
Stack emission monitoring involves the direct measurement of pollutants as they exit an industrial chimney or vent. The primary objective is to determine the exact concentration and mass flow rate of contaminants being released into the atmosphere from that specific source. This data is essential for ensuring that the facility complies with environmental regulations and for providing accurate input for dispersion models.

77. (B) A series of woven or felted bags that capture dust
A fabric filter system, also known as a baghouse, consists of several long, cylindrical bags made from woven or felted materials. As contaminated gas passes through the fabric, particulate matter is trapped on the surface through mechanical mechanisms like sieving and impaction. This collected dust forms a cake that further improves filtration efficiency. This technology is highly effective for removing fine dust.

78. (A) Heavy metals
Industrial effluents frequently contain toxic substances such as lead, mercury, and cadmium. When these liquids interact with soil, these heavy metals can become bound to soil particles or dissolved in soil water. Because many heavy metals do not biodegrade, they accumulate over time and can be absorbed by plants. This leads to contamination of the food chain, posing health risks.

79. (A) Both Statement I and Statement II are true.
Water hardness is a chemical characteristic caused by dissolved multivalent metallic cations, most notably calcium and magnesium. These ions typically enter the water supply as bicarbonates, chlorides, or sulfates. Softening is the technical process used to remove or sequester these specific ions to prevent scaling in pipes and improve the effectiveness of soaps. Both the cause and the process definition are accurate.

80. (B) P-2, Q-4, R-1, S-3
Acid rain is primarily triggered by emissions of sulfur and nitrogen oxides. The urban heat island effect results from city surfaces absorbing and retaining solar radiation. Eutrophication in water bodies is caused by the runoff of nutrients like nitrogen and phosphorus from agricultural and urban areas. Marine pollution is frequently associated with large-scale oil spills in the ocean. Matching causes is essential.

81. (D) Volatile organic compounds (VOCs) from paints and furnishings.
Indoor air quality is significantly affected by emissions from common household items. Volatile organic compounds are released from a variety of sources, including paints, varnishes, cleaning agents, and new furnishings. These gases can accumulate in enclosed spaces with poor ventilation, leading to health issues such as headaches and respiratory irritation. Unlike industrial or volcanic emissions, VOCs represent a pervasive indoor pollution source.

82. (B) It helps capture representative concentrations, especially for pollutants that vary over time.
The duration of air quality sampling is a critical factor because pollutant levels in the atmosphere fluctuate due to changing weather conditions and emission patterns. By collecting a sample over an appropriate length of time, such as twenty-four hours, monitors can capture a more representative average. This approach reduces the impact of short-term spikes and ensures data is reliable for environmental standards.

83. (B) (b) and (d) only
Ionizing radiation possesses sufficient energy to remove electrons from atoms, which can lead to significant biological damage. Effective radiation protection is based on the core principles of minimizing exposure time, increasing distance from the source, and using appropriate shielding materials. However, it is incorrect to say all radiation is man-made, as natural sources exist. Furthermore, effects are not always immediately visible.

84. (D) The total amount of dissolved ionic substances (salts).
Electrical Conductivity is a measure of a water sample's ability to conduct an electric current, which is directly related to the concentration of dissolved ions. Higher concentrations of salts, such as chlorides and sulfates, result in higher conductivity values. Therefore, measuring EC provides a quick and reliable indication of the

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total dissolved solids and overall salinity of the water for treatment.

85. (A) Implementing and enforcing international conventions like MARPOL.
Abating marine pollution requires a coordinated global effort, as oceans cross national boundaries. The MARPOL convention is the primary international agreement aimed at preventing pollution from ships, including oil, chemicals, and garbage. By implementing and strictly enforcing such regulations, countries can significantly reduce the discharge of harmful substances into the sea. This legal framework is essential for protecting marine ecosystems.

86. (B) Uses a catalyst to promote oxidation (burning) of the pollutant at a lower temperature.
Catalytic combustion is a sophisticated method for controlling gaseous pollutants, particularly hydrocarbons. It utilizes a solid catalyst to facilitate chemical oxidation, allowing the reaction to occur at much lower temperatures than conventional thermal incineration. This efficiency reduces fuel consumption and minimizes the formation of additional nitrogen oxides. Hazardous gases are transformed into harmless substances like water vapor before release.

87. (B) Atmospheric stability of the given region.
Atmospheric stability is determined by comparing the actual vertical temperature profile of the air with the dry adiabatic lapse rate. If the ambient temperature decreases more rapidly than the adiabatic rate, the atmosphere is considered unstable, promoting vertical mixing. If it decreases more slowly, the atmosphere is stable, which can trap pollutants. This relationship is a fundamental concept used to predict dispersion.

88. (A) Viable coliform bacteria
The Most Probable Number technique is a vital statistical tool in environmental microbiology used specifically to estimate the density of viable coliform bacteria in water. This method involves a series of fermentation tests that indicate the presence of these organisms. It is widely used because it provides a reliable measure of potential fecal contamination, ensuring water supplies meet safety standards for consumption.

89. (A) Both A and R are true and R is the correct explanation of A.
Wet collectors, commonly known as scrubbers, are versatile pollution control devices capable of removing both particulate matter and gaseous contaminants from exhaust streams. They function by bringing the gas into contact with a scrubbing liquid, which physically traps the particles. Simultaneously, soluble gases can be absorbed into the liquid or chemically neutralized. This dual capability makes them highly effective for industries.

90. (A) It is formed by chemical reactions in the atmosphere.
A secondary air pollutant is defined by the fact that it is not emitted directly from a source like a tailpipe or factory chimney. Instead, it is produced through complex chemical and physical reactions occurring within the atmosphere between primary pollutants and other atmospheric components. Ozone and sulfuric acid are classic examples. These pollutants often reach highest concentrations far downwind from sources.

91. (A) a, b, c, d
The activated sludge process follows a specific sequence to treat wastewater. First, wastewater enters the aeration tank where microorganisms break down organic matter. Next, the mixture flows to a final clarifier for secondary settling, where biomass is separated from the liquid. Some settled sludge is cycled back through the return activated sludge line to maintain microbes. Finally, the cleaned liquid is discharged.

92. (B) Decreasing gas velocity and increasing particle size and density.
The performance of a settling chamber is governed by the principles of gravitational settling. Efficiency is improved when the horizontal velocity of the gas is decreased, as this provides more time for particles to fall toward collection hoppers. Additionally, larger and denser particles settle more quickly due to the greater force of gravity. Therefore, these chambers are most effective as pre-cleaners.

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93. (C) Nighttime hours (10 PM to 7 AM)
The Day-Night Average Sound Level, or LDN, is a noise metric that accounts for the increased sensitivity of people to noise during sleep. To

the longer wavelengths are easier to match and counteract electronically. It is a preferred solution for mitigating persistent industrial humming.

25. (C) Constructing sound barriers along a highway.
Passive noise abatement methods rely on physical structures and materials to obstruct, reflect, or absorb sound energy without the use of electronic systems. Constructing large concrete or wooden barriers along highways is a classic example of this approach. These barriers create a sound shadow for adjacent residential areas, reducing the transmission of traffic noise. Unlike active systems that generate anti-noise, passive methods work through matter.

26. (B) (a), (b), (c), and (d) only
Indian environmental regulations specify permissible noise levels for four distinct area categories to ensure public health and tranquility. These categories include industrial, commercial, and residential zones, as well as silence zones around hospitals and educational institutions. Each zone has defined limits for both daytime and nighttime. While agricultural activities occur, there is no specific permissible noise level category defined for agricultural zones under these rules.

27. (D) Noise-Induced Hearing Loss (NIHL)
Prolonged exposure to high-intensity sound can cause permanent damage to the delicate hair cells within the inner ear, leading to noise-induced hearing loss. This condition is a primary occupational and environmental health concern worldwide. Unlike temporary hearing shifts, this loss is irreversible and can significantly impact a person's quality of life. Implementing protective measures and adhering to noise exposure limits are essential for preventing health problems.

28. (B) Decibel (dB)
The decibel is the standard unit used to measure sound intensity and is employed to express the equivalent continuous sound level, or Leq. It is a logarithmic unit that represents the ratio of a measured sound pressure to a reference value. Using decibels allows for the convenient representation of the vast range of pressures the human ear can detect. Leq values provide a useful measure.

29. (C) Biological Oxygen Demand
Biological Oxygen Demand refers to the specific amount of dissolved oxygen required by aerobic microorganisms to decompose organic matter present in a water sample at a certain temperature over a set period. It is a vital parameter used to assess the level of organic pollution in water bodies. A high value indicates that more oxygen is being consumed, which can lead to depletion for aquatic life.

30. (B) (a) and (c) only
pH provides a measure of hydrogen ion concentration, indicating the acidity or alkalinity of water. Dissolved oxygen is a critical parameter representing the amount of gaseous oxygen dissolved in the liquid, which is essential for aquatic life. However, turbidity is primarily caused by suspended particles rather than dissolved solids. Furthermore, high Chemical Oxygen Demand values actually indicate high levels of organic pollution in samples.

31. (A) Most Probable Number
The Most Probable Number is a statistical method used in microbiology to estimate the concentration of viable microorganisms, such as coliform bacteria, in a water sample. This test involves inoculating multiple tubes of culture media with varying dilutions of the sample. Based on the pattern of positive results, a statistical table is used to determine the most likely density of bacteria present for consumption safety.

32. (B) Drinking water
Indian Standard IS:10500 (2012) is the primary regulatory document that establishes the quality requirements for drinking water in India. It specifies permissible and desirable limits for various physical, chemical, and bacteriological parameters to ensure the water is safe for human consumption. Compliance with these standards is essential for public health agencies and water utilities to prevent waterborne diseases and protect population from toxins.

33. (B) Aluminum sulfate (Alum)
Aluminum sulfate, commonly referred to as alum, is a widely used chemical coagulant in the treatment of drinking water. When added to water, it reacts to form gelatinous precipitates that neutralize the electrical charges of fine

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Radiation protection is based on the core principles of minimizing the time spent near a source, maximizing the physical distance from it, and utilizing effective shielding materials. These methods all serve to reduce the total dose received by an individual. Conversely, increasing the intensity of the radiation source would directly increase risk and biological damage. Therefore, it is not a protective principle.

103. (A) Both A and R are true and R is the correct explanation of A.
Fine colloidal particles in water are often stable because they carry similar electrical charges that keep them apart. Coagulation and flocculation are necessary to neutralize these charges and facilitate collisions between particles. This leads to the formation of larger, heavier masses called flocs. Because these flocs have a greater mass, they can be removed by gravity during subsequent sedimentation stages.

104. (D) The vertical extent of the atmospheric layer in which pollutants can be mixed by turbulence.
Mixing height refers to the vertical distance from the ground to the base of a stable atmospheric layer, such as an inversion. This height defines the volume of air available for dilution and dispersion of emitted pollutants. A higher mixing height generally leads to lower ground-level concentrations. Understanding this parameter is vital for air quality forecasting and determining industrial emission impacts.

105. (D) (a), (b), (c), (d), and (e)
Assessing water quality requires monitoring a diverse range of indicators. Physical and chemical parameters like pH and Total Dissolved Solids provide information on the chemical state. Biological measures like Biological Oxygen Demand and Most Probable Number assess organic load and fecal contamination. Additionally, testing for heavy metals is essential to ensure safety. All these parameters are integral to comprehensive evaluations.

106. (B) Emitted directly into the atmosphere from a source.
A primary pollutant is a substance that is released into the atmosphere in the same chemical form as it was produced at its source. Common examples include carbon monoxide from vehicles and sulfur dioxide from coal-burning power plants. These pollutants are identifiable at the point of discharge and do not require chemical transformation. This distinguishes them from secondary pollutants formed in air.

107. (B) Kill or inactivate pathogenic microorganisms.
Disinfection is the final critical safeguard in the water treatment process. Its primary purpose is to eliminate or neutralize harmful microorganisms, such as bacteria, viruses, and parasites, that can cause waterborne diseases. Common methods include the addition of chlorine or use of ultraviolet light. While other stages remove solids, disinfection specifically ensures water is biologically safe for safe human consumption.

108. (A) A heat island.
The term heat island refers to the phenomenon where urban areas experience higher air and surface temperatures compared to their surrounding rural regions. This is caused by the concentration of heat-absorbing surfaces like asphalt and concrete, coupled with a lack of vegetation and release of waste heat from human activities. These elevated temperatures can lead to increased energy demand for cooling.

109. (C) Ash from a volcanic eruption.
Air pollution can originate from natural geological processes as well as from human activities. Volcanic eruptions are a significant natural source, releasing large quantities of ash, sulfur dioxide, and other gases into the atmosphere. While these emissions can be extremely hazardous, they occur independently of human influence. This distinguishes them from anthropogenic sources such as vehicle exhausts or factory smoke results.

110. (A) b, c, d, a
The development of photochemical smog follows a distinct chemical sequence. It begins with the emission of primary pollutants, specifically nitrogen oxides and volatile organic compounds. Sunlight then acts on these precursors, triggering complex chemical reactions. A key step involves reaction of atomic oxygen with molecular oxygen to produce ozone. Finally, this leads to the formation of secondary oxidants that characterize smog.

NODIA

128. (A) Annoyance to humans and structural damage to buildings.
Vibrations from industrial activities, transportation, and construction are considered a form of environmental pollution due to tangible negative effects. At low intensities, they can cause significant psychological annoyance and stress for people living nearby. At higher levels, persistent vibrations can lead to structural degradation of buildings, causing cracks and compromising long-term stability. Monitoring and controlling vibration levels is a key aspect.

129. (C) Electrostatic precipitator
Among common air pollution control technologies, the electrostatic precipitator is renowned for its high collection efficiency, especially for sub-micron and very fine particulate matter. By using electrical forces to charge and attract particles, it can capture matter that simple mechanical devices often miss. This makes it a preferred choice for large-scale industrial operations where removal of very fine dust is essential.

130. (A) Both Statement I and Statement II are true.
The L10 noise index is a statistical parameter defined as the sound pressure level that is exceeded for ten percent of the monitoring period. It is commonly used in environmental acoustics to represent the more intrusive or peak noise events in a fluctuating environment. For example, it effectively captures the loudness of passing vehicles on busy roads. Both definition and application are accurate.

131. (D) Turbidity
Turbidity is a key water quality parameter that measures the degree to which light is scattered by suspended particles in the liquid. High turbidity gives water a cloudy appearance and is caused by materials such as silt, clay, and microorganisms. Measuring this property is essential because suspended matter can interfere with disinfection processes. It is typically quantified using a nephelometer in units.

132. (B) (a), (b), and (d)
Urban air quality is profoundly shaped by high volumes of vehicular emissions and the use of line source models to assess street-level pollution. Additionally, the heat island effect can influence local wind patterns and potentially trap contaminants within the city. However, the claim that urban areas have lower ozone concentrations than pristine forests is incorrect, as city air contains precursor levels.

133. (C) The total sound energy a person is exposed to over a period, relative to a standard.
The concept of a noise dose is used to quantify the cumulative amount of sound energy an individual receives over a specific timeframe, such as a work shift. It is expressed as a percentage of the maximum allowable daily exposure defined by standards. This measure takes into account both intensity and duration. Monitoring noise dose is essential in occupational health to prevent damage.

134. (D) They break down complex organic and inorganic compounds into simpler forms.
Soil microorganisms play a vital role in managing agricultural chemicals by breaking down complex synthetic fertilizers. Through natural metabolic processes, these bacteria and fungi decompose chemical compounds into simpler, more stable forms. This biological activity can help plants absorb nutrients more efficiently and can also reduce persistence of residues in soil. This natural degradation process is a key component of soil health.

135. (A) The reduction of dissolved oxygen concentration in water.
The most significant environmental impact of thermal pollution in aquatic systems is the reduction of dissolved oxygen. As temperature of a water body increases, its physical capacity to hold oxygen in solution decreases. Simultaneously, metabolic rates of fish and other organisms rise, increasing demand for oxygen. This combination of lower supply and higher demand can create hypoxic conditions, leading to ecosystem stress.

136. (B) Combustion of natural gas for heating.
Radioactive pollution stems from activities that involve unstable atomic nuclei, such as uranium mining, nuclear power plant operations, and medical use of radioisotopes. These sources can release ionizing radiation into the environment. In contrast, the combustion of natural gas is a chemical process that releases carbon dioxide

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centralized facility. This allows for more effective treatment of diverse industrial wastes and better monitoring of environmental compliance. These plants are key tools for pollution control in industrial zones.

120. (A) Both A and R are true and R is the correct explanation of A.
Marine pollution often transcends national borders because the world's oceans are interconnected systems. Pollutants discharged in one region can be carried vast distances by powerful ocean currents and the natural movement of marine life. Plastic debris and chemical contaminants can travel across entire ocean basins, affecting ecosystems far from source. This makes the management and abatement of marine pollution complex.

121. (C) The decomposition of organic matter and nutrient cycling.
Soil microorganisms are indispensable for a healthy ecosystem because they drive the decomposition of organic matter. Bacteria and fungi break down dead plants and animals, releasing essential nutrients back into the soil in forms that living plants can reabsorb. This nutrient cycling is vital for maintaining soil fertility. Without the constant activity of these microbes, organic waste would accumulate in environment.

122. (B) P-2, Q-1, R-4, S-3
Adsorption is a surface-level phenomenon where gas molecules adhere to a solid. Absorption involves a gas dissolving into the bulk of a liquid solvent. Condensation is the phase change of a substance from a gas into its liquid form, typically achieved through cooling. Combustion is a chemical reaction involving high-temperature oxidation. Correctly defining these terms is essential for understanding various engineering methods.

123. (D) Sulphur Dioxide (SO2)
Sulfur dioxide is a major gaseous pollutant primarily released from the combustion of coal, which naturally contains sulfur. Once in the atmosphere, it undergoes chemical reactions with water vapor and oxygen to form sulfuric acid, a key component of acid rain. This phenomenon can cause widespread damage to forests and lakes. Controlling sulfur dioxide emissions from power plants is a primary goal.

124. (B) (a), (b), (c), and (d) only
The Indian standard for drinking water, IS:10500, provides a comprehensive set of limits for various safety parameters. These include physical attributes like turbidity, chemical indicators like hardness and chlorides, and bacteriological measures like coliform count. Additionally, the standard sets limits for radioactive substances to ensure safety. However, it does not specify parameters related to industrial process efficiency, focusing strictly on consumption.

125. (A) Slow, gentle stirring.
Flocculation is the process where small, destabilized particles are encouraged to collide and form larger clumps, or flocs. This process is best enhanced by slow and gentle stirring, which provides enough movement to facilitate particle collisions without breaking the delicate flocs apart. Proper flocculation is essential because it creates larger masses that can settle more quickly during the subsequent sedimentation phase.

126. (B) Unstable
A super-adiabatic lapse rate occurs when the temperature of the atmosphere decreases with height more rapidly than the dry adiabatic lapse rate. This condition creates an unstable environment where air parcels displaced upwards will continue to rise because they remain warmer than surrounding air. Atmospheric instability is beneficial for dispersion as it promotes strong vertical mixing and helps dilute contaminants over volume.

127. (B) Removal of dissolved organic matter through biological processes.
The primary aim of secondary wastewater treatment is the reduction of dissolved and colloidal organic contaminants that remain after initial physical processes. This is accomplished using biological systems where specialized microorganisms consume organic matter, converting it into biomass and carbon dioxide. By removing these substances, the treatment significantly lowers Biological Oxygen Demand, ensuring that final discharge does not deplete oxygen in rivers.

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Flocculation is a vital stage in water treatment that follows the initial chemical coagulation step. Its primary purpose is to provide gentle mixing that encourages small, destabilized particles to collide and stick together. These collisions lead to formation of larger flocs. Because flocs have greater mass than individual particles, they can be removed much more efficiently by gravity during the subsequent sedimentation phase.

181. (B) A busy highway.
In air pollution modeling, a line source is used to represent an emitter that is continuous along a linear path. A busy highway is the most common example, as it consists of many moving vehicles that act as a single, elongated source of emissions. This differs from point sources like factory chimneys. Using a line source model allows scientists to accurately calculate pollutant concentrations.

182. (A) Coliform bacteria.
The Most Probable Number test is a specialized statistical method used in water microbiology to estimate concentration of viable coliform bacteria. Coliforms are indicator organisms used to signal potential presence of fecal contamination in a water supply. This test is essential for evaluating safety of water for drinking and recreational use. By providing a reliable measure of microbial density, it helps protect public health.

183. (C) Generating anti-noise to cancel the original noise.
Active noise control is an engineering method that uses electronic systems to mitigate unwanted sound. It works by capturing the offending noise and generating an anti-noise wave that has the same amplitude but is out of phase. When these waves meet, they cancel each other out through destructive interference. This is an active method because it requires power, unlike passive methods like barriers.

184. (D) Bioremediation.
Bioremediation refers to the use of living organisms, particularly microorganisms, to remove or neutralize pollutants from a contaminated site. When bacteria and fungi in soil break down complex synthetic fertilizers into simpler components, they are performing a natural form of bioremediation. This process is essential for maintaining soil health and preventing accumulation of chemical residues. Natural biological cycles provide a sustainable cleanup method.

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185. (C) Damage to cellular DNA.
Ionizing radiation possesses high energy that can strip electrons from atoms, creating reactive ions within living tissues. The primary biological consequence of this process is direct or indirect damage to the DNA molecule inside cells. Such damage can lead to mutations or cell death. Understanding this cellular interaction is fundamental to environmental health, as it underpins the safety guidelines for radiation exposure risks.

186. (B) Sulphur Dioxide
Sulfur dioxide is a primary air pollutant released during combustion of fossil fuels, particularly coal. Once it reaches the atmosphere, it undergoes chemical reactions with water vapor and oxygen to form sulfuric acid. This acid then falls to Earth as acid rain, which can severely damage forests and man-made structures composed of limestone. Therefore, controlling sulfur dioxide emissions is a critical component of management.

187. (D) To remove large solid objects and grit.
Primary wastewater treatment is the first stage of the cleaning process and relies on physical mechanisms. Its main purpose is to eliminate large floating objects and heavy grit through screening. This is followed by sedimentation, which allows heavier organic and inorganic solids to settle out of the liquid. By removing these solids initially, the plant protects its downstream pumps and equipment from damage.

188. (A) The arrangement of soil particles into aggregates.
In soil science, structure refers to physical organization and arrangement of individual particles, such as sand, silt, and clay, into larger units called aggregates. This characteristic is different from texture, which describes relative proportions of those particles. A well-developed soil structure is essential for maintaining soil health because it creates pores that allow air and water to move freely within the ground.

189. (C) Concentrating the radioactive source.

and water vapor, but it is not typically a source of radioactive contamination in monitoring.

137. (A) Both A and R are true and R is the correct explanation of A.
Improperly managed landfills and waste dumps are major sources of soil and groundwater contamination. As rainwater percolates through deposited waste, it picks up a variety of organic and inorganic pollutants, creating a toxic liquid known as leachate. If a landfill lacks a proper liner, this leachate can seep into underlying soil and reach aquifers, degrading quality of vital water resources.

138. (D) Using a liquid (usually water) to capture pollutants.
A wet collector, or scrubber, is a pollution control device that utilizes a liquid, most commonly water, to remove contaminants from an air stream. The process involves bringing gas into intimate contact with the liquid through sprays. This contact allows the liquid to physically trap particulate matter and to absorb soluble gaseous pollutants. This versatile technology is widely used to clean exhaust.

139. (B) The plume would disperse above the inversion layer with little to no impact on ground-level concentrations.
When an industrial stack is tall enough to emit its plume above a ground-based inversion layer, the stable air below acts as a physical barrier. This prevents pollutants from mixing downward toward the Earth surface. Instead, the plume disperses horizontally and vertically within more unstable air above the inversion. This condition is generally favorable for local air quality, protecting residents from high concentrations.

140. (A) Soil organic components include only living microorganisms.
While living microorganisms are a vital part of soil organic component, they represent only a small portion of it. The majority of soil organic matter consists of dead biological material, such as plant litter, along with stable humus. Other statements regarding soil texture, structure, and impact of industrial effluents are correct descriptions of soil properties. Accurate definitions are essential for soil quality assessment.

141. (C) Disinfection
Disinfection is the essential final step in municipal drinking water treatment. After water has been clarified through coagulation, sedimentation, and filtration, it is treated with a disinfectant like chlorine to eliminate any remaining pathogenic bacteria or viruses. This process provides a final barrier against waterborne diseases and ensures water remains safe as it travels through the distribution system to individual homes.

142. (A) P-3, Q-4, R-1, S-2
Different noise indices provide specific insights into an acoustic environment. Leq is used to find overall energy-equivalent average sound level over a period. L10 is ideal for identifying peak noise events, such as those from passing traffic. L90 is the standard metric for representing constant background noise levels. LDN is a comprehensive community noise metric that incorporates a penalty for nighttime sounds.

143. (D) Protecting coastal ecosystems like mangroves and coral reefs.
Effective coastal management focuses on preservation of natural ecosystems that provide vital environmental services. Protecting mangroves and coral reefs is a key strategy because these habitats act as natural barriers against storm surges and help prevent erosion. Sustainable management avoids damaging practices like unregulated waste discharge. Instead, it promotes balanced development that preserves the ecological health and resilience of shorelines.

144. (B) Incineration or Combustion
Incineration, or combustion, is an air pollution control method that involves burning gaseous pollutants at very high temperatures. This process chemically oxidizes volatile organic compounds, transforming them into simpler substances like carbon dioxide and water vapor. When properly designed, combustion systems achieve high destruction efficiencies for various contaminants. This technique is particularly useful for managing industrial exhaust streams containing high concentrations of flammable.

145. (A) (a) and (c) only
Weighting networks are standard components in sound level meters used to adjust measurements

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to human hearing. Additionally, vibrations are measurable environmental factors that can have tangible impacts on human health and structural integrity. However, some other statements are incorrect: active noise control uses electronics rather than barriers, and L90 represents background rather than peak noise. Accurate distinctions are vital in acoustics studies.

146. (D) The lowering of the water table around a pumping well.
A cone of depression is a hydro geological feature that forms when water is pumped out of an aquifer through a well. As the pump draws water, the water level in the surrounding ground drops, creating a conical-shaped depression in the water table centered at the well. Size and shape depend on pumping rate and soil permeability. Monitoring this is vital for sustainability.

147. (B) Ozone (O_3)
Ground-level ozone is a classic example of a secondary air pollutant that is a major component of photochemical smog. It is not emitted directly from sources like vehicles but is formed through chemical reactions between primary pollutants, such as nitrogen oxides, in the presence of sunlight. Because of this process, ozone concentrations are often highest during sunny afternoons and can affect areas.

148. (A) Biological oxidation by a biofilm of microorganisms.
A trickling filter is a biological secondary wastewater treatment system. It consists of a fixed bed of media over which wastewater is sprayed. As liquid trickles down, it passes over a biofilm of aerobic microorganisms. These microbes absorb and biologically oxidize the dissolved organic matter in the wastewater. This natural process effectively reduces Biological Oxygen Demand before the water is collected for settling.

149. (C) Industrial, Residential, Rural and Ecologically Sensitive Areas
The National Ambient Air Quality Standards in India are designed to provide levels of protection based on the use of various areas. They specify distinct permissible limits for industrial, residential, and rural zones, reflecting different exposure risks. Additionally, more stringent standards are often set for ecologically sensitive areas to protect fragile ecosystems. This categorized approach ensures that air quality goals are appropriately tailored.

150. (C) a, c, b
Different types of ionizing radiation have vastly different abilities to pass through matter. Alpha particles are the least penetrating and can be stopped by a sheet of paper. Beta particles have moderate penetrating power and can pass through some tissues but are stopped by thin metal. Gamma rays are highly penetrating and require thick lead or concrete for effective shielding from sources.

151. (D) A wide geographical area with multiple small, diffuse sources, like a residential neighborhood.
Area source models are used in air quality dispersion studies to estimate the combined impact of many small emission sources that are impractical to model individually. A typical example is a residential neighborhood where numerous homes each have small heating vents. By treating the area as a single source, modelers can predict the cumulative ground-level concentrations. This approach is essential for regional planning.

152. (B) Electrical Conductivity (EC)
Total Dissolved Solids and Electrical Conductivity are closely related water quality parameters. Since most solids dissolved in water are in an ionic form, such as minerals, they increase the water ability to conduct an electric current. Therefore, a higher concentration of TDS generally results in a higher EC value. Because EC can be measured quickly with a probe, it is surrogate for TDS.

153. (A) Both A and R are true and R is the correct explanation of A.
Fabric filters require regular cleaning because they operate by trapping particles on the surface of the filter medium. Over time, these collected particles form a thick layer known as a dust cake. While this cake helps capture finer particles, it also increases resistance to airflow, known as pressure drop. If not cleaned periodically, the system efficiency will drop, and energy required becomes excessive.

154. (D) It causes a rapid depletion of dissolved oxygen.

The discharge of raw sewage into a river is a major environmental threat because of its high organic content. Aerobic microorganisms in the water consume vast amounts of dissolved oxygen to break down this organic waste. If the load is excessive, the rate of oxygen consumption exceeds re-aeration, leading to rapid depletion. This creates hypoxic conditions that result in death of fish life.

155. (A) Both Statement I and Statement II are true.
Advanced wastewater treatment, commonly known as tertiary treatment, follows primary and secondary stages. Its main objective is to remove specific contaminants that biological processes do not fully address, such as nitrates and phosphates. This high level of treatment is essential for protecting sensitive receiving waters from eutrophication or for preparing water for reuse. Both terminology and functional description are accurate in engineering.

156. (B) The pH of the effluent and the buffering capacity of the soil.
The interaction between industrial effluents and the soil environment is heavily influenced by the chemical properties of both. The pH of the effluent determines the solubility and mobility of many contaminants, particularly heavy metals. Simultaneously, the soil buffering capacity, which is its ability to resist changes in pH, plays a critical role. Understanding these factors is essential for predicting environmental impacts on soil.

157. (B) Constructing an acoustic barrier or wall.
Passive noise control involves use of physical objects to disrupt the path of sound waves without electronic systems. Constructing an acoustic barrier along a busy highway is a primary example. These structures work by reflecting sound back toward the source or absorbing it, thereby reducing intensity that reaches nearby areas. Unlike active systems that require power, passive controls rely on natural properties of materials.

158. (A) It causes the corrosion of metals and erosion of limestone and marble.
Acid rain has significant destructive effects on various man-made and natural materials. Increased acidity of precipitation accelerates the corrosion of metals, such as steel, used in infrastructure. Furthermore, acid rain reacts chemically with calcium carbonate in limestone, causing these materials to gradually dissolve. This leads to deterioration of historic buildings and monuments, posing a serious challenge for the preservation of built regional heritage.

159. (A) (a), (c) and (d) only
A pH value of 7 correctly represents a neutral state for water. High turbidity is known to scatter light, which reduces light penetration in water bodies and can affect aquatic life. Salinity is a standard measure of concentration of dissolved salts. However, statements regarding hardness and BOD are incorrect. Hardness is caused by calcium rather than sodium, and BOD measures oxygen demand for organic decomposition.

160. (B) P-3, Q-4, R-2, S-1
The Gaussian plume model is used for predicting how pollutants disperse from a point source. Wet collectors are versatile devices used for removing both particulates and soluble gases. Fabric filters are highly efficient for capturing dry particulate matter. A Leq meter is the standard tool used to measure average sound level over a period. Correctly matching these to their applications is essential for monitoring.

161. (D) Create ions and free radicals within cells, damaging DNA.
Ionizing radiation causes biological damage by transferring high energy to atoms within living cells. This process strips electrons away, creating highly reactive ions and free radicals. These unstable species can chemically attack and damage vital cellular components, most importantly the DNA molecule. Such damage can lead to mutations or cell death. Understanding this mechanism is fundamental to the fields of radiological safety and medicine.

162. (B) Dissolved ions of calcium and magnesium.
Water softening is a specialized treatment process aimed at reducing the concentration of dissolved multivalent metallic cations, specifically calcium and magnesium. These ions are responsible for water hardness, which can lead to scale buildup in pipes and appliances and reduce effectiveness of soaps. Common softening methods include ion exchange and lime-soda processes. Removing

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these ions improves functional quality of water for various community applications.

163. (C) Nitrogen dioxide (NO_2)
A primary air pollutant is one that is released directly from its source into the atmosphere. Nitrogen dioxide is a prime example, as it is emitted during high-temperature combustion processes in motor vehicles and industrial power plants. In contrast, pollutants like ozone and peroxyacetyl nitrate are secondary pollutants formed through reactions in air. Understanding sources of pollutants is essential for developing effective emission control strategies.

164. (D) How often samples are collected.
In the context of environmental monitoring, the frequency of sampling specifies the schedule or interval at which individual samples are taken. For example, a program might require sampling once an hour or once a day. This parameter is distinct from sampling duration, which refers to the length of time for a single collection event. Choosing correct frequency is vital for capturing periodic changes in pollutant.

165. (C) Temperature
The lapse rate is a fundamental meteorological term that describes the rate at which the temperature of the atmosphere changes with a change in altitude. Under normal conditions, temperature decreases as height increases, which is referred to as a positive lapse rate. If temperature increases with altitude, it is an inversion. Monitoring these changes is critical for assessing atmospheric stability and dispersion of airborne pollutants.

166. (D) (a), (b), (c) and (d)
Particulate control devices utilize various physical and electrical mechanisms. Settling chambers rely on gravity to remove large particles. Centrifugal collectors, like cyclones, use inertia to separate matter from the gas stream. Fabric filters are highly effective at mechanically trapping particles on their surface. Finally, electrostatic precipitators charge particles electrically before collecting them on plates. All these statements provide accurate descriptions of core industrial principles.

167. (D) Absorption
Absorption is a key chemical engineering process used for the control of gaseous pollutants. It involves the transfer of gas molecules into a liquid solvent, where they are dissolved or chemically neutralized. This method is particularly effective for removing soluble gases such as sulfur dioxide from industrial exhaust. Unlike mechanical devices like fabric filters designed for particulate matter, absorption addresses the molecular nature of gases.

168. (A) Response of the human ear.
The A-weighting network is a frequency filter used in sound level meters to adjust raw acoustic data so it correlates better with human hearing. Since the human ear is naturally less sensitive to very low and very high frequencies, the A-weighting system reduces these parts of the sound spectrum. The resulting value, measured in dB(A), reflects perceived loudness more accurately than unweighted sound measurements.

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169. (C) Background noise.
In environmental acoustics, the L90 index represents the sound pressure level that is exceeded for ninety percent of the total monitoring time. Because it filters out short-duration peak sounds from passing vehicles, it provides a stable measure of underlying residual noise in an area. For this reason, L90 is widely used to characterize baseline background noise levels of residential and industrial environments.

170. (A) Both A and R are true and R is the correct explanation of A.
Secondary wastewater treatment is fundamentally a biological process designed to remove dissolved organic matter. It utilizes large populations of microorganisms which use the organic pollutants as a food source. Through their natural metabolism, these microbes convert contaminants into biomass and carbon dioxide, effectively reducing the Biological Oxygen Demand of water. This biological conversion is essential for stabilizing waste before the effluent is discharged.

171. (C) Sand, silt, and clay
Soil texture is a fundamental physical property defined by the relative proportions of sand, silt, and clay particles in the soil mineral fraction. These three components are distinguished by

their size, with sand being the coarsest and clay being the finest. The specific mix of these particles determines the soil ability to retain water and its overall suitability for various types of plants.

172. (B) An urban area that is significantly warmer than its surroundings.
A heat island is a climatic phenomenon where urban centers experience significantly higher temperatures than surrounding rural areas. This is primarily caused by concentration of heat-absorbing surfaces like asphalt, lack of vegetation for cooling, and emission of waste heat from human activities. These elevated temperatures can impact health, increase energy consumption for cooling, and worsen air quality by promoting ground-level ozone formation.

173. (B) Inertia and centrifugal force
A cyclone separator functions by converting the linear velocity of an incoming gas stream into a high-speed rotational flow. As the gas spins, the inertia of the particles within it causes them to resist changes in direction. This inertia, combined with the resulting centrifugal force, drives heavier particles toward the outer walls of the chamber. Once they strike the walls, particles slide down into a hopper.

174. (A) Both Statement I and Statement II are true.
Biological Oxygen Demand and Chemical Oxygen Demand are two essential measures used to determine organic load in water. BOD represents specific amount of oxygen required by aerobic microorganisms to biodegrade organic matter. In contrast, COD measures amount of oxygen needed to chemically oxidize both biodegradable and non-biodegradable organic substances. Both statements provide accurate definitions of these parameters, which are vital for assessment.

175. (A) P-3, Q-1, R-2, S-4
Each stage of water treatment serves a specific goal for ensuring safe water. Coagulation involves adding chemicals to destabilize colloidal particles. Disinfection is the final step used to kill pathogenic microorganisms. Filtration is a mechanical process designed to remove fine suspended solids. Softening specifically targets removal of hardness-causing calcium and magnesium ions. Matching these processes with their objectives is fundamental for treatment.

176. (B) Damage to marine ecosystems and contamination of seafood.
Marine pollution has devastating impacts on the health of oceanic and coastal environments. Contaminants such as plastics and oil can cause widespread damage to fragile ecosystems like coral reefs. Additionally, toxic substances can accumulate in the tissues of fish, leading to contamination of seafood. This poses significant risks to human health and the livelihoods of fishing communities. Protecting marine resources is vital.

177. (C) Soil micro-organisms
The primary agents responsible for the breakdown of pesticides in soil are indigenous microorganisms, including various species of bacteria and fungi. These microbes use the chemical components of pesticides as energy sources during their natural metabolic processes. This biological degradation transforms complex substances into simpler, less harmful compounds. While physical factors influence the rate, the core mechanism for removing pesticide residues is biological activity.

178. (D) The vertical height available for pollutant dispersion.
In air pollution meteorology, the mixing depth refers to the vertical height from ground to the base of a stable layer of air. This depth defines the total volume of the atmosphere in which pollutants can be effectively diluted by turbulent air movements. A greater mixing depth is generally favorable for air quality, as it allows pollutants to spread out, resulting in lower concentrations.

179. (B) (a), (b), (c) and (d) only
Gaseous pollutants are controlled using techniques that address their molecular form, such as adsorption onto solids, absorption into liquids, condensation through cooling, and combustion. These methods are specifically designed for gases. In contrast, a settling chamber is a mechanical device that utilizes gravity to remove solid particulate matter from an air stream. It is not a suitable method for gaseous pollutants.

180. (B) Encourage small particles to aggregate into larger flocs.

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111. (D) It primarily consists of carbonic acid from atmospheric CO2.
While carbon dioxide dissolves in rainwater to form weak carbonic acid, this is a natural process giving normal rain slightly acidic pH. Acid rain, as a pollution problem, is primarily caused by sulfur dioxide and nitrogen oxides reacting to form much stronger sulfuric and nitric acids. These acids significantly lower pH, leading to environmental damage. Carbonic acid is not the primary component.

112. (B) The number of samples collected in a given time period (e.g., per day or per week).
In environmental monitoring programs, the frequency of sampling refers to how often data is collected over a set timeframe. This could mean taking measurements once an hour, daily, or weekly. Establishing proper frequency is essential to ensure monitoring captures periodic variations in pollutant levels. This is distinct from the duration of an individual sample, which describes the specific collection event.

113. (C) A coffee filter.
A fabric filter operates on the same basic mechanical principle as a standard coffee filter. In both systems, a fluid, which is air for the industrial filter and water for the coffee maker, is passed through a porous medium. The physical structure of the medium traps solid particles on its surface while allowing fluid to pass through. This mechanism removes fine dust.

114. (D) Statement I is false but Statement II is true.
Centrifugal collectors, or cyclones, are generally not efficient for capturing very fine particles, especially those smaller than one micron. Their separation principle relies on inertial and centrifugal forces rather than gravity. These forces drive heavier particles to outer walls, but they are less effective for smaller, lighter matter that follows gas streams. Cyclones struggle with small particles, making the efficiency statement inaccurate.

115. (A) Increased acuity of hearing.
Noise pollution has a wide range of documented negative impacts on human health. These include psychological stress, significant annoyance, and severe sleep disturbances. Long-term exposure can also lead to physiological issues like hypertension and cardiovascular problems. However, excessive noise does not improve hearing. In fact, it typically leads to temporary or permanent hearing loss and decrease in the ability to detect sounds.

116. (C) (a), (c), and (d)
Point sources are characterized by discharging pollutants at specific, identifiable locations through pipes or channels. Non-point sources are diffuse, delivering contaminants indirectly over large areas. Urban stormwater runoff is a classic example of a non-point source as it collects pollutants from streets. However, agricultural runoff is also a non-point source rather than a point source, making the second statement totally incorrect.

117. (B) The amount of oxygen required to chemically oxidize both biodegradable and non-biodegradable organic matter.
Chemical Oxygen Demand is a critical water quality parameter that quantifies the amount of organic matter in a sample. It is determined by using a strong chemical oxidant to react with both biodegradable and more resistant non-biodegradable organic substances. This measurement provides a faster and more comprehensive assessment of total organic load in industrial wastewater compared to biological tests alone.

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118. (A) The relative proportions of sand, silt, and clay.
In soil science, the term texture specifically refers to the physical makeup of soil based on the percentage of sand, silt, and clay particles. These three mineral fractions are categorized by their diameter, and their relative proportions determine fundamental characteristics. Texture influences how well soil can retain water, its ability to support plant species, and its physical behavior under varying conditions.

119. (C) Offer a centralized treatment facility for effluents from a group of small and medium-sized enterprises.
Common Effluent Treatment Plants provide an efficient wastewater management solution for clusters of small and medium-sized industries. Instead of each factory building an expensive treatment unit, they pool resources into one

Radiation protection is built on three core principles: minimizing time of exposure, maximizing distance from the source, and using appropriate shielding materials. These methods all serve to reduce the total amount of radiation a person absorbs. Conversely, concentrating a radioactive source would increase its intensity and potential for harm, making it the opposite of protective. Therefore, it is not a safety principle.

190. (A) Both A and R are true and R is the correct explanation of A.
Urban areas are frequently warmer than rural surroundings, a condition known as the heat island effect. This occurs because cities are composed of materials like asphalt and concrete that absorb more solar radiation. Additionally, cities have significantly less vegetation, which reduces amount of natural cooling provided by evaporation. Both observation of elevated temperatures and explanation regarding surface absorption are accurate descriptions of this phenomenon.

191. (D) LDN
The Day-Night Average Sound Level, or LDN, is a comprehensive noise metric used to assess community noise impact over twenty-four-hour periods. It is unique because it includes a ten-decibel penalty added to sound levels measured during nighttime hours, typically from ten in the evening until seven in the morning. This weighting reflects increased sensitivity to noise during sleep. The resulting value provides representative measures.

192. (B) A polishing stage that removes specific contaminants like nutrients or residual solids.
Tertiary or advanced wastewater treatment is a final polishing stage that follows primary and secondary processes. Its primary goal is to remove specific pollutants not fully eliminated in earlier stages, such as nitrogen, phosphorus, and remaining fine suspended solids. This high level of treatment is essential for protecting sensitive ecosystems from eutrophication and for ensuring treated water is clean enough for reuse.

193. (C) Predicting pollutant concentrations from a continuous point source.
The Gaussian plume model is a fundamental mathematical tool used in environmental engineering to estimate how pollutants spread from a continuous point source, such as an industrial smokestack. The model assumes that dispersion follows a normal distribution from the centerline of the plume. By incorporating variables like wind speed and atmospheric stability, scientists can predict ground-level concentrations. This information is vital for compliance.

194. (A) Both Statement I and Statement II are true.
Chlorination is a widely used and effective method for disinfecting drinking water in municipal treatment plants. By adding chlorine to water supplies, utilities can successfully kill or inactivate a broad range of pathogenic microorganisms, including bacteria and viruses. This process provides a final barrier against waterborne diseases and ensures water remains safe as it travels through distribution networks to individual homes. Both statements are accurate.

195. (D) (a), (b), (c), (d) and (e)
Marine pollution originates from a diverse range of land-based and sea-based activities. Large-scale oil spills and routine offshore drilling operations directly contaminate the ocean. On land, industrial effluents and municipal sewage discharge are often released into coastal waters or transported there by rivers. Additionally, agricultural runoff carries nutrients and pesticides into the sea. All these sources contribute to degradation of marine ecosystems.

196. (B) Sustainably manage the resources of the coastal zone.
The core objective of coastal management is the sustainable use and protection of resources along the shoreline. This practice involves balancing competing demands for environmental conservation, economic development, and social needs. By protecting vital ecosystems like mangroves while regulating industrial and tourism activities, coastal management ensures long-term health. It also involves planning for future challenges like sea-level rise and coastal erosion.

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197. (D) Industrial effluents can introduce persistent toxic metals into the soil.
Soil pollution is a serious environmental concern, as industrial effluents often contain toxic

215. (B) (a), (b), (c), (e)
Accurate air pollution modeling relies on understanding several meteorological factors. Mixing height establishes vertical limit for dispersion, while a positive lapse rate indicates temperature decreases with altitude. The Gaussian plume model is used for point sources, and line source models are standard for highways. However, statement regarding inversion layers is incorrect because inversions restrict rather than enhance dispersion. These concepts are fundamental.

216. (B) To convert toxic pollutants into less harmful substances.
A catalytic converter is a vital emission control device found in modern vehicles. Its primary function is to facilitate chemical reactions that transform toxic gases produced by engines into less harmful substances. Specifically, it converts carbon monoxide and nitrogen oxides into carbon dioxide and nitrogen. This significantly reduces the environmental impact of automobile transportation. Understanding these devices is essential for urban air quality.

217. (D) Drinking Water
Indian Standard IS:10500 (2012) is the primary regulatory framework in India that specifies the quality requirements for drinking water. It sets permissible and desirable limits for physical, chemical, and bacteriological parameters to ensure water is safe for human consumption. Compliance with these national standards is mandatory for public water utilities and helps protect the population from waterborne diseases and toxic substances.

218. (A) Sand filtration
In conventional water treatment plants, the physical process of sedimentation is immediately followed by sand filtration. After larger flocs have settled to the bottom of the basin by gravity, water still contains some fine suspended matter. Sand filtration provides an effective way to remove these remaining particles by passing water through sand. This step significantly improves water clarity before final chemical disinfection.

219. (C) Coliform bacteria
The Most Probable Number method is a specialized statistical technique used in the microbiological analysis of water. Its primary target is the detection of coliform bacteria, which serve as indicator organisms for fecal contamination. The presence of coliforms signals that pathogenic microorganisms could be present in water supplies. This test is essential for ensuring that water for drinking meets safety standards.

220. (A) P-4, Q-3, R-1, S-2
Each environmental parameter is quantified using specific units. Noise levels are measured in A-weighted decibels, or dB(A). Radioactivity is expressed using the Becquerel, which measures rate of radioactive decay. Turbidity, a measure of water clarity, is quantified in Nephelometric Turbidity Units. Water hardness is traditionally reported as milligrams per liter of calcium carbonate. Correctly matching these parameters with units is fundamental.

221. (D) Centrifugal collection
Gaseous pollutants are controlled using methods that target their molecular nature, such as absorption into liquids and adsorption onto solid surfaces. These techniques are specifically designed to remove gases from industrial exhaust. In contrast, centrifugal collection is a mechanical process that relies on inertial forces to separate solid particulate matter from a gas stream. While effective for dust, it is not suitable.

222. (B) Temperature increases with altitude.
A temperature inversion occurs when a layer of warmer air sits above a layer of cooler air near the ground. This is an inversion of normal conditions where temperature decreases with height. These layers are highly stable and act as lids that trap pollutants near the surface. Inversions can significantly worsen air quality in urban areas by preventing vertical dispersion of various emissions.

223. (C) Discharge of heated water from power plants and industries.
The primary cause of thermal pollution in aquatic environments is discharge of vast quantities of heated water from industrial facilities and power plants. These plants use water from nearby rivers to cool machinery, and the resulting warm water is returned to the source. This increase in temperature can disrupt ecosystems by reducing

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206. (A) 2, 1, 3, 4
A typical municipal wastewater treatment plant follows a specific chronological sequence to ensure effective cleaning. The process begins with bar screens to remove large debris. The water then flows to a primary clarifier where heavier solids are allowed to settle. This is followed by the aeration tank, which is the biological secondary treatment stage. Finally, disinfection is carried out to eliminate pathogenic microorganisms.

207. (D) Water Vapor
Criteria air pollutants are specific atmospheric contaminants for which health-based standards are established. Standard examples include lead, ozone, and carbon monoxide, all of which have direct negative impacts on human health. While water vapor is a natural component of the atmosphere and a significant greenhouse gas, it is not classified as a criteria air pollutant. These regulations focus on man-made hazardous pollutants.

208. (A) Both A and R are true and R is the correct explanation of A.
In water quality analysis, the Chemical Oxygen Demand value is consistently higher than the Biological Oxygen Demand value for the same sample. This is because COD uses a strong chemical oxidant to measure nearly all organic matter, including both biodegradable and resistant non-biodegradable substances. BOD only measures the oxygen required by microorganisms to decompose the biodegradable portion over specific periods of time.

209. (B) Sound Level Meter
A sound level meter is the standard electronic instrument used to measure acoustic levels. It typically consists of a microphone that converts sound pressure changes into electrical signals, which are processed and displayed in decibels. Modern meters calculate various statistical indices such as Leq and L90. These tools are essential for environmental noise monitoring, occupational health assessments, and ensuring compliance with noise regulations.

210. (A) To allow heavy, flocculated particles to settle out by gravity.
Sedimentation is a critical physical stage in the treatment of drinking water. Once fine particles have been aggregated into larger flocs through coagulation and flocculation, the water enters a quiet basin where flow velocity is reduced. This allows force of gravity to pull flocs down to the bottom of the tank, where they are removed. This process significantly reduces water turbidity.

211. (C) River discharge carrying agricultural runoff
Marine pollution is often a trans-boundary problem caused by land-based activities. Rivers act as major pathways, carrying contaminants from far inland to the sea. Agricultural runoff is a primary example, as it carries fertilizers and pesticides into river systems, which then discharge into coastal waters. This can lead to issues like eutrophication and contamination. Effective management of agricultural practices is essential.

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212. (D) Total Dissolved Solids
TDS stands for Total Dissolved Solids, which is a measure of the combined content of all inorganic and organic substances present in water in a molecular or ionized form. This includes common salts like chlorides, sulfates, and bicarbonates. Measuring TDS is a key part of water quality assessment, as high levels can affect taste of drinking water and industrial suitability.

213. (C) Statement I is true but Statement II is false.
Industrial effluents are a well-documented source of heavy metal contamination in soil, as they often contain toxic elements like lead and mercury. These metals can accumulate in soil over time. However, unlike organic pollutants, heavy metals cannot be biologically degraded by soil microorganisms because they are elements. While some microbes can change their mobility, they remain in the environment indefinitely.

214. (D) Natural and Anthropogenic
Air pollutants are categorized based on their origin into two main types: natural and anthropogenic. Natural sources include geological events such as volcanic eruptions and forest fires. Anthropogenic sources result specifically from human activities, such as emissions from motor vehicles and industrial power plants. Distinguishing between these sources is essential for atmospheric science and for developing targeted environmental regulations and management strategies.

then collected on plates. This technology is capable of removing even very fine dust and is widely used in power plants to meet stringent air quality standards.

233. (C) Total time over which a single sample is collected.
In environmental monitoring, the period of sampling refers to the specific duration during which an air sample is continuously collected. For example, a sampler might be programmed to run for eight hours or a full twenty-four-hour day. This time frame is essential to ensure that the sample represents the average conditions during that interval. It is distinct from frequency of sampling.

234. (D) Release of cold water from a dam's base
Thermal pollution typically refers to unnatural warming of water bodies, often caused by industrial cooling water or heated effluent. These temperature increases can significantly disrupt aquatic ecosystems. However, release of deep, cold water from the base of a dam results in a decrease in water temperature. While this change still impacts local life, it is not categorized as warming associated with thermal pollution.

235. (C) Large, heavy particles from a gas stream.
The main function of a settling chamber is to remove large and heavy particulate matter from industrial gas streams using the principle of gravitational settling. By significantly reducing the horizontal velocity of the gas as it enters the chamber, gravity is given sufficient time to pull heavier particles down into hoppers. These simple devices are often used as pre-cleaners before finer particulate removal.

236. (A) Both A and R are true and R is the correct explanation of A.
Constructing noise barriers along busy highways is a common and effective passive method for mitigating traffic noise. These physical structures work by reflecting sound waves back toward the road and absorbing a portion of acoustic energy. This creates a shadow zone behind the barrier where noise levels are significantly reduced for residents. Both assertion and explanation of reflection and absorption are accurate.

237. (D) Leq
In water quality analysis, common physical and chemical indicators include pH, Dissolved Oxygen, and Biological Oxygen Demand. These parameters provide essential information about the environmental health of a water body. However, Leq is an acoustic metric used to measure average sound levels over time and is not used in water testing. Distinguishing between metrics for different types of pollution is fundamental.

238. (B) The probable number of coliform bacteria.
The Most Probable Number test is a key statistical method used in microbiological analysis of water. Its primary goal is to estimate the concentration of viable coliform bacteria in a sample. Coliforms are used as indicator organisms because their presence signals potential contamination from human waste and possible presence of harmful pathogens. This test is essential for ensuring that water supplies meet safety.

239. (C) Soil micro-organisms.
Biological degradation of pesticides in the soil environment is primarily carried out by indigenous microorganisms, such as bacteria and fungi. These microbes possess metabolic pathways to break down complex chemical compounds, using them as sources of energy. This process is a vital natural function that helps reduce persistence of toxic residues in soil and protects groundwater. Understanding microbial activity is essential.

240. (D) International agreements and national regulations.
Abating marine pollution requires a coordinated effort because oceanic contaminants often cross national boundaries. Effective management is addressed through a combination of international agreements, such as the MARPOL convention, and strictly enforced national regulations that control discharges. These legal frameworks set limits on release of pollutants like oil into the sea. By promoting international cooperation, these measures help protect ecosystems.

241. (A) Corrosion and degradation.
Atmospheric pollutants like sulfur dioxide have a profound impact on various man-made materials. These gases can react with moisture to form acids that accelerate corrosion of metal structures and

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dissolved oxygen levels. Managing these discharges is essential for protecting life.

224. (D) Damage to DNA and cells.
Ionizing radiation possesses sufficient energy to displace electrons from atoms, creating highly reactive ions within living tissues. The key biological consequence of this process is damage to vital cellular components, most importantly the DNA molecule. This can lead to cell mutations or impaired function. Understanding this cellular interaction is fundamental for radiation safety. Guidelines are designed to minimize risks of biological changes.

225. (C) Adding chemicals like alum to cause small particles to clump together.
Coagulation is a vital chemical stage in treatment of drinking water. It involves adding chemicals, such as aluminum sulfate, to neutralize electrical charges that keep fine suspended particles apart. Once neutralized, these particles can collide and stick together, forming larger clumps known as flocs. This process is essential because it transforms tiny impurities into larger masses that are easily removed through sedimentation.

226. (B) The equivalent continuous sound level.
In acoustics, Leq represents the equivalent continuous sound level, which is a measure of total sound energy over a specific period. Since environmental noise is often fluctuating, Leq provides a single decibel value that represents the constant sound level that would have the same total energy as the actual varying sound. This metric is the most common parameter used for noise exposure.

227. (B) The arrangement of soil particles into aggregates.
Soil structure is a physical property that describes how individual soil particles, such as sand, silt, and clay, are organized into larger units called aggregates. This characteristic is different from texture, which describes proportions of those particles. A well-developed structure is critical for maintaining soil health because it creates pores for air and water movement and supports various root developments.

228. (A) Ozone formed in the troposphere
Ground-level ozone is a classic example of a secondary air pollutant. It is not emitted directly from sources like vehicles. Instead, it is formed through complex chemical reactions between primary pollutants, such as nitrogen oxides and volatile organic compounds, in the presence of sunlight. In contrast, pollutants like carbon monoxide and sulfur dioxide are primary pollutants released directly into the air.

229. (D) (a), (b), (c), and (d)
All the given statements correctly describe the stages of conventional water treatment. Coagulation destabilizes suspended particles by neutralizing their charges, allowing them to come together. Flocculation then gently mixes the water so these particles form larger flocs. During sedimentation, the flocs settle under gravity, and finally, filtration removes the finer particles left behind, ensuring cleaner and safer water.

230. (B) Human health effects and structural damage
Vibrations from industrial activities and construction are recognized as a form of environmental pollution. They can have tangible negative impacts on both people and built environments. Persistent vibrations can cause significant psychological annoyance and stress for nearby residents. At higher intensities, vibrations can lead to structural damage in buildings, such as development of cracks. Monitoring vibration levels is therefore a key aspect.

231. (B) Physical processes like screening and sedimentation.
Primary wastewater treatment is the initial stage of processing and relies almost exclusively on physical mechanisms. This phase involves screening to capture large floating objects and grit chambers to remove heavy matter. Subsequently, sedimentation tanks allow heavier solids to settle out of the liquid. This stage is essential for reducing the suspended solids load and protecting biological treatment equipment from damage.

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232. (A) Particulate matter.
An electrostatic precipitator is a highly efficient industrial device used specifically to control emissions of particulate matter. It works by passing contaminated gases through an electrical field where particles receive a charge and are

267. (B) Cyclone collector
Some industrial collectors utilize a spiral motion to separate solid particles from a gas stream. As the gas enters the device, it is forced into a high-speed rotating flow. The resulting centrifugal force pushes the heavier particles outward toward the walls of the collector, where they lose momentum and fall into a collection hopper at the base.

268. (A) Gravitational settling
Reducing the velocity of a gas stream allows larger particles to fall out due to the constant pull of the Earth. This simple device uses the principle of gravity to clear heavy particulates from industrial emissions. As the gas moves slowly through a large chamber, the weight of the particles overcomes the air resistance, causing them to settle.

269. (C) Fabric filter
Certain pollution control systems function by drawing air through a physical barrier that traps solid matter while allowing the gas to pass. This mechanism is very similar to how a household appliance uses a bag or filter to collect dust. In industrial settings, large fabric bags are used to capture fine particulates from the exhaust air before it is released.

270. (D) Wet collectors use a liquid medium to capture particles, while fabric filters use a solid medium.
Controlling particulate emissions can be achieved using either liquid or solid capture media. One method involves bringing the polluted gas into contact with water or another liquid to trap the particles. In contrast, the other method relies on a dry, solid fabric material to act as a physical barrier. The choice depends on the specific characteristics of the waste.

271. (C) Adsorption involves a solid adsorbent holding gas molecules, while absorption involves a gas dissolving in a liquid solvent.
Managing gaseous waste requires different techniques based on whether the gas is dissolved or attached to a surface. One process involves the molecules of the pollutant being caught on the surface of a solid material. The other process occurs when the gas enters and dissolves within a liquid solvent. Both are effective for removing various harmful industrial gases.

272. (B) Catalytic combustion
Oxidizing pollutants at high temperatures can be energy-intensive and costly. To improve efficiency, specialized materials are often introduced into the process to facilitate the chemical reaction at significantly lower temperatures. This method speeds up the destruction of harmful organic compounds by providing a reactive surface, making the overall emission control process more sustainable for industrial applications.

273. (D) Condensation
When industrial processes involve expensive or reusable organic vapors, it is beneficial to convert them back into a liquid state for recovery. This is achieved by cooling the gas stream or increasing the pressure until the vapors reach their dew point. This method allows companies to reduce waste while reclaiming valuable materials that would otherwise be lost.

274. (A) Poor urban air quality
The high density of motorized transport in populated areas significantly degrades the local atmosphere. Exhaust from cars and trucks releases a variety of primary pollutants that contribute to smog and other health-related issues. Because these emissions are concentrated where people live and work, they are a primary driver of poor environmental quality in modern metropolitan settings.

275. (C) Absorption
Removing sulfur dioxide from industrial exhaust can be done by passing the gas through a reactive liquid mixture. This process allows the gaseous pollutant to be taken up and dissolved by the liquid, where a chemical reaction often occurs to neutralize it. This technique is a practical application of dissolving a gas into a fluid for pollution control.

276. (A) L90
To evaluate the acoustic environment, researchers use various indices to describe how sound levels fluctuate. One specific measure identifies the sound level that is exceeded during almost the entire duration of the monitoring period. Because this value represents a level that is nearly always present, it is the standard indicator used to define constant background noise.

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chemical erosion of building materials such as limestone. Over time, this leads to physical degradation of infrastructure and historical monuments. Monitoring air quality is therefore essential for preservation of built environments and heritage.

242. (A) c, a, d, b
The process of eutrophication follows a specific chronological sequence. It begins with an excessive load of nutrients entering a water body from runoff. This enrichment stimulates a rapid algal bloom, which eventually dies off. This is followed by decomposition of dead algae by aerobic bacteria, which consume vast amounts of dissolved oxygen. Finally, this leads to oxygen depletion, resulting in death.

243. (D) During the night
The Day-Night Average Sound Level, or LDN, is a weighted acoustic metric designed to quantify noise exposure over twenty-four-hour periods. It reflects the fact that noise is generally more annoying to people during the night when they are trying to sleep. To account for increased sensitivity, a ten-decibel penalty is added to levels measured during nighttime periods, typically spanning from evening.

244. (B) To treat mixed effluents from a cluster of small industries.
A Common Effluent Treatment Plant is a centralized facility designed to treat combined wastewater generated by several small-scale industrial units. This approach is efficient because it allows multiple businesses to share costs of building a sophisticated treatment system that they could not afford individually. By pooling resources, these plants provide consistent pollution control, ensuring that industrial effluents meet environmental standards.

245. (C) Several feet of concrete or lead
Gamma rays are a highly penetrating form of ionizing radiation that can pass through most common materials. Effective shielding against these high-energy photons requires dense substances. Several feet of concrete or lead are standard requirements for protecting people from gamma sources in industrial settings. Understanding these shielding requirements is fundamental to radiation safety, as simple materials like paper are insufficient to block rays.

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246. (A) Both Statement I and Statement II are true.
Soil texture and soil structure are two fundamental physical properties that define the soil environment. Texture refers specifically to the relative percentages of sand, silt, and clay particles in the mineral portion. Structure, on the other hand, describes way these individual particles are arranged and organized into larger units called aggregates. Both statements correctly define these properties for health and movement.

247. (C) Hardness-causing ions like Ca^{2+} and Mg^{2+}
Water softening is a chemical treatment process specifically designed to reduce concentration of multivalent metallic cations in a water supply. The most significant of these are calcium and magnesium ions, which are responsible for water hardness. Softening methods, such as ion exchange, remove or sequester these ions to prevent scale buildup in plumbing and to improve functional quality for cleaning.

248. (D) Vehicular emissions
In many modern cities, vehicular emissions are recognized as the most significant source of urban air pollution. The concentration of automobiles on city streets releases large quantities of pollutants such as carbon monoxide and fine particulate matter at ground level. These emissions contribute directly to formation of smog and can have negative impacts on health. Managing traffic is a critical component.

249. (A) Improved cognitive function
Noise pollution is associated with a wide range of documented negative impacts on human health. These include hearing loss, significant sleep disturbance, and increased levels of physiological stress that can lead to cardiovascular issues. However, excessive noise does not improve cognitive function. In fact, it typically has the opposite effect, impairing concentration and performance. Recognizing these harmful effects is essential for setting standards.

250. (A) P-2, Q-1, R-4, S-3
Many environmental concepts are specifically associated with different types of pollution. The Gaussian plume model is a tool for studying air

pollution dispersion. Biological Oxygen Demand is a key metric used in water pollution assessment. Leq is a standard measure for quantifying noise pollution levels over time. The heat island effect is a significant phenomenon related to thermal pollution in environments. Correctly matching concepts is fundamental.

251. (B) Primary pollutants are directly emitted, while secondary pollutants are formed through atmospheric chemical reactions.
Primary pollutants originate directly from identifiable sources, such as industrial stacks or vehicle exhausts. They enter the atmosphere in the same form as they were emitted. Conversely, secondary pollutants are produced through complex chemical reactions within the atmosphere itself. These reactions often involve sunlight and interaction between multiple primary pollutants or existing atmospheric components.

252. (A) A secondary pollutant
Atmospheric chemicals like ozone are not typically released from a specific source directly. Instead, they result from the chemical interaction of nitrogen oxides and volatile organic compounds. This process is frequently catalyzed by solar radiation. Because these substances arise from reactions occurring within the air rather than direct emission, they are classified as secondary pollutants in environmental studies.

253. (C) Widely present and pose a significant risk to public health
Environmental regulatory agencies identify specific common pollutants as criteria air pollutants because of their ubiquitous presence in the environment. These substances are targeted because they present significant risks to public health and overall ecological welfare. Regulating these specific pollutants allows authorities to set benchmarks that protect the most vulnerable populations from widespread exposure to harmful atmospheric conditions.

254. (D) They can be enhanced by managing the emission of primary pollutants to inhibit secondary pollutant formation.
Effective management of environmental quality relies on understanding how different pollutants interact within the atmosphere. Since secondary pollutants are formed through reactions involving primary emissions, controlling the initial release of primary substances can significantly inhibit the formation of more complex harmful agents. This proactive approach focuses on mitigating the foundational sources to prevent broader atmospheric degradation and secondary contamination.

255. (C) Anthropogenic source : Carbon monoxide from vehicular emissions
Anthropogenic sources refer specifically to environmental contaminants resulting from human activities rather than natural events. Carbon monoxide released from vehicles serves as a prime example of this category. In this context, the substance is emitted directly into the air as a primary pollutant during the combustion of fossil fuels, reflecting a clear link between human activity and direct emission.

256. (B) To provide legal concentration limits for pollutants in the general outdoor atmosphere.
National standards for ambient air quality serve as a critical regulatory framework by establishing the maximum permissible concentrations of specific pollutants in the outdoor environment. These benchmarks are legally enforceable and provide a standard for assessing general air safety across different regions. By setting these limits, authorities can monitor compliance and implement necessary measures to protect public health.

257. (D) Ambient monitoring assesses general air quality in an area, while stack monitoring measures pollutants at their direct source of release.
Monitoring the general outdoor environment focuses on assessing the quality of air that the public breathes within a specific geographic area. This differs from source monitoring, which specifically measures the concentration of pollutants being discharged directly from an industrial outlet or chimney. Understanding both levels is essential for determining overall environmental impact and ensuring industrial compliance with regulations.

258. (A) Ensuring the collected air quality data is representative and accurate.

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Collecting environmental data requires careful planning regarding when and how often measurements are taken. Establishing specific periods and durations for sampling ensures that the resulting data accurately represents the actual conditions of the environment over time. Without these strategic decisions, the information gathered might be skewed by temporary fluctuations, leading to incorrect assessments of air quality.

259. (C) Measuring particulate matter concentration directly from a factory chimney.
When measuring particulate matter directly from a high-velocity gas stream in a chimney, it is vital to ensure that the sample collected is truly representative. This requires matching the sampling velocity with the velocity of the gas flow in the stack. This specialized technique prevents bias in particle size distribution, ensuring that the measurement reflects the actual emissions.

260. (A) Monitoring provides the data used to assess compliance with the limits set by NAAQS.
Establishing environmental standards is only effective if there is a systematic way to verify whether those standards are being met. Monitoring provides the empirical data necessary to compare current pollutant levels against the legal thresholds defined by the national guidelines. This relationship allows regulatory bodies to evaluate the success of pollution control policies and enforce necessary legal requirements.

261. (D) Increased pollutant concentrations near the source.
The vertical extent to which pollutants can disperse is limited by atmospheric boundaries. When the mixing depth is low and the atmosphere is stable, vertical movement is restricted, preventing contaminants from being diluted in higher layers of the air. This combination causes pollutants to remain trapped near the ground level, significantly increasing their concentration close to the source.

262. (B) Line source model
Modeling the spread of pollutants from a continuous stream of vehicles along a highway requires a specific mathematical approach. Since the emissions are distributed along a path rather than a single point, a model designed for linear sources is most appropriate. This method calculates how contaminants disperse away from the road, helping planners assess the impact on nearby residents.

263. (C) The vertical layer of the atmosphere available for pollutant dispersion.
The vertical space available in the lower atmosphere for the dilution and dispersal of pollutants is known as the mixing height. This layer is influenced by local meteorological conditions and temperature gradients. A larger volume within this layer allows for better dispersion, while a restricted height forces pollutants to concentrate in a smaller area, impacting the quality of air.

264. (D) Lapse rates influence atmospheric stability, which in turn affects how pollutants disperse.
The rate at which temperature changes with altitude determines how stable or unstable the atmosphere is. This stability directly impacts the vertical movement of air parcels and the pollutants they carry. In unstable conditions, air moves more freely, promoting better dispersion, whereas stable conditions suppress vertical mixing, leading to higher concentrations of pollutants at the ground level.

265. (A) Atmospheric chemical reactions involving pollutants like SO_2 and NOx.
Atmospheric moisture can react with certain chemical pollutants, such as sulfur dioxide and various nitrogen oxides, to produce acidic compounds. These substances eventually fall back to the Earth as precipitation, causing damage to ecosystems and infrastructure. This environmental phenomenon is a direct consequence of chemical transformations that occur once primary pollutants are released into the atmosphere from various sources.

266. (B) Electrostatic precipitator
Sophisticated air pollution control systems can remove very fine particles by utilizing electrical forces. The process involves passing the contaminated gas through a field where particles receive an electric charge. These charged particles are then attracted to and collected on metal plates with the opposite charge, allowing the cleaned gas to pass through and exit the system.

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substances like lead, mercury, and cadmium. These heavy metals can become bound to soil particles, where they persist for many years because they do not biologically degrade. Over time, these contaminants can be absorbed by plants and enter the food chain, posing long-term health risks to people and animals.

198. (A) Calcium and magnesium ions.
Hardness in water is a chemical characteristic primarily caused by presence of dissolved multivalent metallic cations. Calcium and magnesium ions are the most significant contributors to this condition. These ions typically enter water supplies through natural weathering of minerals like limestone. While not harmful to health, high hardness can cause scale buildup in plumbing and reduce effectiveness of soaps. Understanding causes is essential.

199. (C) Depletion of dissolved oxygen, potentially leading to fish kills.
High Biological Oxygen Demand in a river indicates a large amount of organic pollution. Aerobic microorganisms in the water consume vast quantities of dissolved oxygen to break down this organic waste. If the BOD is extremely high, the rate of oxygen consumption can exceed the rate at which oxygen is replenished. This leads to rapid depletion of dissolved oxygen, potentially resulting in fish kills.

200. (A) P-2, Q-1, R-4, S-3
Carbon monoxide is a gaseous primary pollutant emitted directly from combustion sources. Ozone is a secondary pollutant formed through chemical reactions in the atmosphere. Dust is a particulate primary pollutant released directly from various activities. Peroxyacetyl nitrate is another secondary pollutant associated with photochemical smog. Correctly matching these pollutants to their primary or secondary categories is essential for understanding their atmospheric behavior.

201. (D) Sieving and interception
Fabric filters, often used in industrial baghouses, remove particulate matter through several mechanical mechanisms. As contaminated gas passes through porous fabric, larger particles are captured on the surface through sieving. Finer particles are trapped through interception and impaction as they come into contact with fibers. This process is highly efficient and can remove even very fine dust. Fabric filters rely on physical barriers.

202. (B) O_3
Ozone is a triatomic molecule composed of three oxygen atoms, which is represented by the chemical formula O_3. It is a highly reactive gas that occurs both in the upper atmosphere and at ground level as a major component of smog. In the troposphere, it is a secondary pollutant formed by reaction of nitrogen oxides and volatile organic compounds. Understanding its makeup is fundamental.

203. (C) Generating an out-of-phase sound wave.
Active noise control is a sophisticated technique that uses electronic systems to mitigate unwanted sound. The process involves a microphone that captures offending noise and a control system that generates a secondary sound wave. This new wave is identical in amplitude to the original noise but is exactly out of phase. When these waves meet, they cancel each other out through destructive interference.

204. (D) Texture, structure, and organic components.
The physico-chemical properties of soil encompass its fundamental physical and chemical characteristics. This includes texture, which is the proportion of sand, silt, and clay, and structure, which describes arrangement of these particles into aggregates. Additionally, organic components, such as decaying plant matter and humus, play a vital role in soil health. These properties influence ability to retain water and support plant growth.

205. (A) The replacement of vegetation with heat-absorbing surfaces like asphalt.
The urban heat island effect is primarily caused by physical changes that occur during urbanization. As natural landscapes with vegetation are replaced by infrastructure, surfaces like asphalt and concrete become dominant. These materials have high thermal mass, meaning they absorb and store large amounts of solar energy. This trapped heat is slowly released at night, keeping city centers much warmer than surrounding rural areas.

277. (D) Adjust the measurement to better align with human auditory perception.
Sound measurement devices do not naturally perceive noise in the same way the human auditory system does. Weighting networks are mathematical adjustments applied to raw data to simulate the ear's variable sensitivity to different frequencies. By using these networks, researchers can ensure that recorded noise levels accurately reflect the actual intensity and potential annoyance experienced by people.

278. (B) A passive method
Mitigating noise can involve either active cancellation or physical obstruction. When a solid structure is placed between a noise source and a residential area, it acts as a shield that blocks or absorbs the sound waves. This approach does not involve creating a secondary sound to cancel the noise but relies on the physical properties of the barrier.

279. (C) Incorporates a penalty for noise occurring during nighttime hours.
Some noise metrics are designed to account for the increased sensitivity of people to sounds during certain times of the day. Unlike standard average measures, this index applies a specific mathematical penalty to noise occurring at night. This adjustment reflects the greater potential for sleep disturbance and annoyance during late hours compared to similar noise levels during the day.

280. (D) The steady sound level containing the same total acoustic energy as a fluctuating sound.
Fluctuating sound levels can be difficult to compare over time. To simplify this, scientists use a metric that calculates a constant, steady sound level that contains the same total amount of acoustic energy as the varying noise measured. This provides a single value that represents the cumulative exposure to noise energy over a specific period of time.

281. (A) A high level of pollution by biodegradable organic waste.
The amount of oxygen required by microorganisms to break down organic substances in water is a key indicator of its purity. A high demand for oxygen suggests that there is a large amount of biodegradable organic matter present. This condition often results from the discharge of waste, which can deplete the oxygen needed by other aquatic life.

282. (B) Turbidity
The clarity of a water body is often affected by the presence of tiny particles that remain suspended rather than settling. Measuring the degree to which these particles scatter light provides an assessment of the water's cloudiness. This physical characteristic is important for both aesthetic quality and the health of aquatic ecosystems that rely on light penetration.

283. (B) Estimating the population of indicator bacteria.
Assessing the safety of water for human consumption requires testing for the presence of harmful microorganisms. Since it is difficult to count every individual cell, statistical methods are used to estimate the most likely concentration of specific indicator bacteria, such as coliforms. This analysis helps determine the risk of waterborne diseases and the effectiveness of disinfection.

284. (A) BOD measures oxygen demand for biological decomposition, while COD measures oxygen demand for chemical oxidation.
There are two main ways to measure the oxygen demand in a water sample. One focuses on the oxygen consumed by biological organisms during the decomposition of organic matter. The other uses strong chemical agents to oxidize both organic and inorganic substances. While related, the chemical method generally provides a higher value as it includes more compounds.

285. (C) IS:10500, 2012.
Regulatory authorities establish specific guidelines to ensure that water provided for public use is safe. In the Indian context, a particular set of standards defines the required physical, chemical, and microbiological characteristics for potable water. These specifications act as a legal benchmark that treatment facilities must meet before the water is considered suitable for human consumption.

286. (D) To cause small suspended particles to aggregate into larger flocs.
Many impurities in raw water are too small to settle out by gravity on their own. To address this,

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high moisture content. Which approach would be most suitable to improve its fuel quality before combustion?
(A) Directly incinerating the raw waste
(B) Composting the entire waste stream
(C) Sending the waste directly to a landfill to generate gas
(D) Processing the waste into Refuse Derived Fuel (RDF)

31. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Composting is an effective method for managing the organic fraction of municipal solid waste.
Reason (R) : It is an aerobic process where microorganisms decompose organic matter into a stable, humus-like substance.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

32. All of the following are benefits of vermicomposting EXCEPT:
(A) It produces a nutrient-rich organic fertilizer (vermicast).
(B) It can effectively process hazardous and heavy metal-contaminated waste.
(C) It is a relatively rapid process compared to traditional composting.
(D) It improves soil aeration, porosity, and water retention capacity.

33. What is the primary cause-and-effect relationship in the process of biomethanation of solid waste?
(A) Aerobic bacteria consume organic matter, producing carbon dioxide and water.
(B) Anaerobic microorganisms digest organic matter, producing biogas (methane and carbon dioxide).
(C) High temperatures cause the thermal breakdown of waste into syngas.
(D) Earthworms consume organic waste, producing nutrient-rich castings.

34. Consider the following statements about Refuse Derived Fuel (RDF):
(a) RDF is a processed form of MSW.
(b) The production of RDF involves removing non-combustible materials.
(c) RDF has a higher calorific value than raw MSW.
(d) RDF is typically produced in the form of pellets or fluff.
Which of the above statements are correct?
(A) (a) and (c) only
(B) (b), (c) and (d) only
(C) (a), (b), (c) and (d)
(D) (a), (b) and (d) only

35. Which of the following is the most important parameter to maintain for efficient aerobic composting?
(A) Complete absence of oxygen.
(B) A high concentration of heavy metals to aid microbial activity.
(C) An optimal carbon-to-nitrogen (C/N) ratio, typically around 25:1 to 30:1.
(D) A very low moisture content, below 10%.

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36. Fuel pellets derived from solid waste are a form of:
(A) Raw municipal solid waste
(B) Hazardous waste
(C) Biogas
(D) Refuse Derived Fuel (RDF)

37. Which of the following statements about sanitary landfilling is correct?
(A) It is an uncontrolled and unscientific method of dumping waste.
(B) It is primarily a method for recovering energy from waste.
(C) It involves the controlled disposal of waste on land with measures to prevent environmental pollution.
(D) It does not require any daily cover of soil or other materials.

38. The liquid that seeps through solid waste in a landfill, containing dissolved and suspended pollutants, is known as:
(A) Sludge
(B) Leachate

296. (D) A Heat Island
Large cities often experience higher temperatures than the surrounding countryside. This is caused by the concentration of heat-absorbing surfaces like asphalt and concrete, combined with a lack of vegetation and the release of waste heat from vehicles and buildings. This localized warming creates a unique climate within metropolitan areas that can impact energy use and public health.

297. (A) Biological effect of ionizing radiations on living cells.
The primary concern with radioactive materials is the high-energy radiation they emit, which can penetrate living tissues. This ionizing radiation has the power to disrupt the chemical structure of molecules within cells, including genetic material. Such damage can lead to mutations, cell death, and serious long-term health consequences for humans and other organisms exposed to the source.

298. (B) Land-based runoff and oil spills.
Oceans are subject to contamination from a variety of human activities. Significant sources include the discharge of pollutants from land that are carried by rivers and runoff into the sea. Additionally, accidents involving ships can release large amounts of oil. These sources, along with plastic waste, create significant threats to the health and biodiversity of marine ecosystems worldwide.

299. (B) A decrease in dissolved oxygen levels.
Discharging warm water into lakes or rivers can have immediate negative effects on aquatic life. As the temperature of the water rises, its capacity to hold oxygen decreases. This reduction in available oxygen can suffocate fish and other organisms, while also altering the types of species that can survive in the area, leading to a less diverse ecosystem.

300. (A) Limit human exposure to ionizing radiations.
Because ionizing radiation is inherently dangerous, strict rules are established to minimize the risk to people. These regulations set limits on how much radiation an individual can safely receive in both professional and public settings. Protection strategies focus on using physical shields, maintaining a safe distance from sources, and minimizing the time spent in areas where radiation is present.

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from households to a central bin site.
(D) A system where waste is hauled through a network of high-pressure pneumatic tubes.

16. Which of the following pairs of waste collection systems and their characteristics is correctly matched?
(A) Hauled Container System - Best for densely populated areas with low waste generation per location.
(B) Stationary Container System - The container is never moved from the point of collection.
(C) Hauled Container System - Collection vehicles are mechanically simple and do not require lifting mechanisms.
(D) Stationary Container System - The collection vehicle hauls the full container to the disposal site.

17. Arrange the following activities in the operational sequence of a Stationary Container System (SCS) for solid waste collection.
(a) Driving to the next container location.
(b) Emptying the container into the collection vehicle.
(c) Depositing the waste collected at a transfer station or disposal site.
(d) Arriving at a container location and positioning the truck.
Choose the correct sequence:
(A) c, d, b, a
(B) d, b, a, c
(C) a, d, c, b
(D) b, a, d, c

18. A municipal planner is designing a collection route for a new residential area. Which factor is most critical for optimizing the route's efficiency?
(A) Minimizing non-collection distance and avoiding left turns where possible
(B) The brand of collection trucks available
(C) Ensuring the route passes by the city hall
(D) Starting the collection in the least populated area first

19. All of the following are primary functions of a solid waste transfer station EXCEPT:
(A) To act as a central point where smaller collection vehicles deposit their load.
(B) To compact the waste to reduce its volume.
(C) To separate hazardous waste from municipal solid waste.
(D) To load waste into larger vehicles for long-haul transport to a disposal site.

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20. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Transfer stations are economically viable only when the haul distance to the final disposal site is significantly long.
Reason (R) : The primary economic benefit of a transfer station comes from the cost savings achieved by using larger, more efficient vehicles for long-distance transport, which offsets the station's operational costs.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

21. Which of the following pairs regarding solid waste transportation is incorrectly matched?
(A) Large Haul Vehicles - Used for long-distance transport from transfer station.
(B) Route Optimization - Aims to reduce fuel consumption and time.
(C) Small Collection Vehicles - Used for transport from transfer station to landfill.
(D) Transfer Station - Facilitates the switch from small to large transport vehicles.

22. Consider the following statements regarding the design of an efficient solid waste collection route:
(a) To start the route as close to the garage as possible.
(b) To maximize the number of sharp turns and U-turns.
(c) To service congested areas during peak traffic hours.
(d) To ensure one-way streets are traversed in the correct direction.
(e) To collect on steeper streets while driving downhill.
Which of the above statement(s) is/are correct?

(D) Hydrogen content

8. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Proximate analysis is a crucial first step in evaluating the potential of solid waste for thermal conversion processes like incineration.
Reason (R) : It provides data on moisture, volatile matter, fixed carbon, and ash, which collectively determine the heating value and combustion characteristics of the waste.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

9. What is the most appropriate term for the analysis that determines the elemental composition of solid waste, including carbon, hydrogen, oxygen, nitrogen, and sulphur?
(A) Proximate analysis
(B) Compositional analysis
(C) Ultimate analysis
(D) Gravimetric analysis

10. Which of the following statements about solid waste generation rates is incorrect?
(A) Waste generation rates are uniform across a city, with no variation between zones.
(B) Generation rates tend to increase with the level of economic development.
(C) Seasonal variations can significantly influence waste generation rates and composition.
(D) The unit for expressing waste generation rate is often kg/capita/day.

11. Consider the following statements regarding the sources of solid waste:
(a) Demolition and construction sites are major sources of inert waste like concrete and bricks.
(b) Commercial sources like restaurants primarily generate food waste.
(c) Agricultural sources contribute wastes such as crop residues and animal manure.
(d) Industrial processes exclusively produce non-hazardous waste.
Which of the above statements are correct?
(A) (a), (b) and (d) only
(B) (b) and (c) only
(C) (a), (b) and (c) only
(D) (a) and (d) only

12. The high moisture content frequently found in municipal solid waste in tropical countries has a significant negative impact on which waste processing technology?
(A) Composting
(B) Incineration
(C) Biomethanation
(D) Vermicomposting

13. What does the term 'fixed carbon' in proximate analysis represent?
(A) The total carbon content of the waste
(B) The carbon tied up in complex organic molecules
(C) The combustible residue left after volatile matter is driven off
(D) The non-combustible carbon in the form of carbonates

14. Given the following statements:
Statement I : Ultimate analysis is essential for designing air pollution control devices for waste incinerators.
Statement II : The amount of sulphur and chlorine in the waste, determined by ultimate analysis, dictates the potential formation of SOx and HCl.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

15. In the context of solid waste collection, what defines a Hauled Container System (HCS)?
(A) A system where storage containers are picked up, transported to disposal, and returned.
(B) A system where a large container is emptied by a collection vehicle at the source.
(C) A system using manual labor to haul waste

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harmless.

48. Consider the following statements about hazardous waste treatment methods:
(a) Neutralization is primarily used for corrosive wastes.
(b) Incineration destroys organic hazardous constituents at high temperatures.
(c) Precipitation is used to remove dissolved metals from liquid waste streams.
(d) Solidification is a process that increases the mobility of contaminants.
Which of the above statements are correct?
(A) (a) and (d) only
(B) (b), (c) and (d) only
(C) (a), (b) and (c) only
(D) (a) and (b) only

49. Which hazardous waste treatment method involves the chemical conversion of hazardous constituents to less toxic or non-hazardous forms through the transfer of electrons?
(A) Neutralization
(B) Oxidation-Reduction
(C) Precipitation
(D) Stabilization

50. The final disposal of treated hazardous waste residue is most commonly done in a:
(A) Secure hazardous waste landfill
(B) Municipal solid waste compost plant
(C) River or an ocean
(D) Public park as a soil conditioner

51. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Incineration is a common treatment method for organic hazardous wastes.
Reason (R) : High-temperature combustion can effectively destroy toxic organic compounds, converting them into less harmful substances like CO_2 and water.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

52. What is the primary goal of hazardous waste management?
(A) To maximize the economic profit from waste materials.
(B) To mix hazardous waste with municipal solid waste to dilute its effect.
(C) To store all hazardous waste indefinitely without treatment.
(D) To protect human health and the environment from the potential hazards of the waste.

53. E-waste is a term used for:
(A) Waste from power generation plants.
(B) Waste paper and other stationery from offices.
(C) Discarded electrical and electronic equipment.
(D) Waste generated from ecological research facilities.

54. Given the following statements:
Statement I : E-waste contains both valuable materials like gold and copper, and toxic substances like lead and mercury.
Statement II : The disposal of e-waste in municipal landfills is environmentally benign.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

55. Which of the following is NOT a recommended method for the environmentally sound handling and disposal of e-waste?
(A) Refurbishment and reuse of electronic devices.
(B) Recovery of precious metals in controlled, state-of-the-art facilities.
(C) Segregation at source and collection through formal channels.
(D) Open burning to extract metals.

56. The main source of fly ash is:
(A) The combustion of coal in thermal power plants.
(B) The incineration of municipal solid waste.
(C) The smelting of metallic ores.

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(A) (a), (b), and (c) only
(B) (a), (d), and (e) only
(C) (b), (c), and (d) only
(D) (c), (d), and (e) only

23. What is the most appropriate reason for using transfer stations in a large metropolitan area's solid waste management system?
(A) To provide a location for the permanent disposal of all city waste.
(B) To reduce transportation costs by consolidating waste into larger vehicles.
(C) To encourage residents to bring their waste directly to a central facility.
(D) To facilitate secondary sorting of materials before their final disposal.

24. The two main types of container systems used in solid waste collection are:
(A) Hauled and stationary systems
(B) Open-top and closed-top systems
(C) Manual and automated systems
(D) Residential and commercial systems

25. Match the processing techniques in List I with their primary purposes in List II.
List I: (Solid Waste Processing Technique)
P. Recycling
Q. Composting
R. Incineration
S. Landfilling
List II: (Primary Purpose)
1. Volume reduction and energy recovery
2. Final disposal on land
3. Conversion of materials into new products
4. Biological decomposition of organic matter
Choose the correct answer from the options given below:
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-1, R-2, S-3
(D) P-2, Q-3, R-4, S-1

26. What does recovery of materials for recycling primarily involve?
(A) The segregation of valuable components like paper, glass, and metals from the mixed waste stream.
(B) The process of burning waste to produce energy.
(C) The biological decomposition of organic waste into a soil conditioner.
(D) The final disposal of waste in a sanitary landfill.

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27. Which of the following statements about recycling solid waste is correct?
(A) Recycling always consumes more energy than producing goods from virgin materials.
(B) Only metals and glass can be recycled; paper and plastics cannot.
(C) The process of recycling generates more pollution than traditional manufacturing.
(D) Recycling helps conserve natural resources and reduces the volume of waste sent to landfills.

28. Consider the following statements regarding the direct manufacture of products from solid waste:
(a) Building materials like bricks and tiles can be manufactured from fly ash.
(b) Plastic lumber can be made from recycled plastic waste.
(c) Organic compost is a direct product manufactured from biodegradable waste.
(d) All solid waste components can be directly manufactured into new products without any processing.
Which of the above statements are correct?
(A) (a) and (d) only
(B) (b), (c) and (d) only
(C) (a), (b) and (c) only
(D) (a) and (b) only

29. Given the following statements about energy generation from solid waste:
Statement I : Refuse Derived Fuel (RDF) is produced by shredding and dehydrating solid waste to enhance its fuel characteristics.
Statement II : RDF typically has a lower and more uniform calorific value compared to raw municipal solid waste.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

30. A municipality wants to generate energy from its municipal solid waste which has a high percentage of non-combustible materials and

CHAPTER 07

Solid and Hazardous Waste Management

1. Which of the following best defines solid waste?
(A) Any discarded substance, whether in a solid, liquid, or gaseous state, that has lost its utility.
(B) Any discarded solid material from human or animal activities that is useless or unwanted.
(C) Strictly hazardous chemical materials in a solid state that necessitate specialized disposal protocols.
(D) Organic biological materials that are naturally biodegradable and suitable for large-scale composting.

2. Municipal Solid Waste (MSW) is a term used to describe waste collected from which primary sources?
(A) Residential, commercial, institutional, and municipal sources
(B) Industrial manufacturing and specialized processing units only
(C) Agricultural fields, animal farms, and forestry operations
(D) Hospitals, clinics, and biomedical research laboratories

3. Given the following statements:
Statement I : The generation rate of solid waste is typically higher in high-income countries compared to low-income countries.
Statement II : The composition of solid waste remains constant regardless of the economic status of a region.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

4. Which of the following is considered a key physical characteristic of solid waste?
(A) The carbon-to-nitrogen ratio
(B) The calorific value
(C) The presence of heavy metals
(D) The density (mass per unit volume)

5. Match the items in List I with the descriptions in List II.
List I: (Waste Component)
P. Garbage
Q. Rubbish
R. Ashes
S. Demolition Waste
List II: (Typical Description)
1. Residue from the burning of wood, coal, and coke
2. Wastes from construction and remodeling of buildings
3. Putrescible solid wastes from food preparation
4. Non-putrescible solid wastes, both combustible and non-combustible
Choose the correct answer from the options given below:
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-1, R-4, S-2

6. A city's solid waste management board observes a significant increase in the density of collected waste. What is a likely implication of this change for waste transportation?
(A) The volume capacity of collection trucks will be reached before their weight capacity.
(B) The weight capacity of collection trucks will be reached before their volume capacity.
(C) Transportation costs will decrease due to lighter loads and reduced fuel consumption.
(D) The frequency of collection trips will need to be reduced because of the increased mass.

7. All of the following are determined during the proximate analysis of solid waste EXCEPT:
(A) Moisture content
(B) Volatile matter
(C) Ash content

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(C) Syngas
(D) Condensate

39. What is the primary purpose of a liner system at the base of a sanitary landfill?
(A) To promote the rapid decomposition of waste.
(B) To collect landfill gas for energy production.
(C) To provide a stable base for waste placement.
(D) To prevent the contamination of underlying soil and groundwater by leachate.

40. Incineration of solid waste is a process of:
(A) Controlled combustion to reduce waste volume and recover energy.
(B) Biological decomposition in the absence of oxygen.
(C) Compacting and burying waste in a designated land area.
(D) Using earthworms to convert waste into compost.

41. A key environmental concern associated with the incineration of solid waste is:
(A) The generation of large volumes of leachate.
(B) The requirement of large land areas.
(C) The emission of air pollutants like dioxins, furans, and heavy metals.
(D) The slow rate of waste processing.

42. Consider the following components of a modern sanitary landfill's management and design:
(a) A leachate collection and treatment system.
(b) A landfill gas collection and management system.
(c) Daily and final cover materials.
(d) A bottom liner system.
(e) An open dumping policy for all types of waste.
Which of the above are essential components?
(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (c), and (e) only
(D) (a), (b), and (e) only

43. Which of the following is NOT a characteristic of hazardous waste?
(A) Ignitability
(B) Corrosivity
(C) Reactivity
(D) Biodegradability

44. What is the most significant health impact associated with exposure to hazardous wastes?
(A) Improved immune system response.
(B) A wide range of acute and chronic diseases, including cancers and neurological disorders.
(C) A temporary increase in physical strength.
(D) Enhanced nutrient absorption.

45. Match the hazardous waste characteristics in List I with their definitions in List II.
List I: (Hazardous Waste Characteristic)
P. Ignitability
Q. Corrosivity
R. Reactivity
S. Toxicity
List II: (Definition)
1. Can cause or contribute to an increase in mortality or serious illness
2. Is normally unstable and readily undergoes violent change
3. Is aqueous and has a pH less than or equal to $_2$ or greater than or equal to 12.5
4. Is a liquid and has a flash point of less than 60°C
Choose the correct answer from the options given below:
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-1, S-2
(C) P-4, Q-3, R-2, S-1
(D) P-2, Q-1, R-4, S-3

46. The treatment method that adjusts the pH of acidic or alkaline hazardous waste towards a neutral value is called:
(A) Precipitation
(B) Oxidation-reduction
(C) Solidification
(D) Neutralization

47. What is the primary principle of the solidification and stabilization method for hazardous waste treatment?
(A) To convert the waste into a less soluble, mobile, or toxic form by binding it within a solid matrix.
(B) To destroy the hazardous constituents by burning them at high temperatures.
(C) To separate the hazardous components from the waste stream.
(D) To adjust the pH of the waste to render it

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chemicals are added to neutralize the electrical charges on these particles, allowing them to stick together. This process creates larger, heavier masses that can then be easily removed in the subsequent stages of the treatment process.

287. (C) Secondary treatment
After large solids are removed, wastewater still contains dissolved organic contaminants. The next stage of treatment utilizes the natural metabolic processes of microorganisms to consume and break down these dissolved substances. This biological process effectively reduces the organic load of the water, making it much safer to discharge back into the environment or for further treatment.

288. (B) Filtration
To ensure water clarity and remove the finest remaining suspended matter, it is passed through beds of granular materials. Layers of sand and gravel act as a physical sieve that traps particles as the water flows through. This step is essential for producing high-quality water that is free from visible impurities and many types of microbes.

289. (D) Primary treatment is a physical process for solids removal, while secondary treatment is a biological process for dissolved organics.
The initial phase of cleaning wastewater involves physical methods to separate large objects and heavy solids from the liquid. Once these are removed, the focus shifts to a biological phase where bacteria are used to eliminate dissolved organic materials. This two-step approach ensures that both the visible debris and the invisible organic pollutants are effectively managed.

290. (A) Remove specific pollutants like nutrients after the secondary stage.
Standard treatment processes may not remove all pollutants, such as excessive nutrients like nitrates and phosphates. To protect sensitive water bodies from issues like algal blooms, a final stage of treatment is often employed. This specialized phase uses various chemical or physical techniques to target and remove remaining contaminants that survived the earlier primary and secondary stages.

291. (C) Relative proportions of sand, silt, and clay.
The physical makeup of soil is characterized by the size of the inorganic particles it contains. Specifically, the varying percentages of sand, silt, and clay determine the overall feel and properties of the soil. This composition is a fundamental characteristic that influences how the soil holds water, allows air to circulate, and supports different types of vegetation.

292. (A) Soil micro-organisms.
Soil is home to a diverse community of living organisms that perform vital ecological functions. Many of these microscopic creatures have the ability to break down complex chemicals, including those found in agricultural fertilizers and pesticides. This natural process of decomposition is essential for preventing the long-term accumulation of toxic substances and maintaining the health of the ecosystem.

293. (D) Texture refers to particle size composition, while structure refers to the arrangement of those particles.
While both terms describe physical aspects of the soil, they refer to different levels of organization. One term focuses on the size of individual particles like clay or sand. The other term describes how these individual particles are grouped together into clumps or aggregates. Both characteristics together determine the soil's ability to support life and manage water.

294. (B) Interacting with and altering the soil's natural components.
The introduction of waste materials from manufacturing can significantly damage the land. When these substances are discharged onto the ground, they interact with the soil's existing minerals and organic matter. This can disrupt the natural chemical balance and physical properties of the soil, leading to a loss of fertility and the poisoning of local biological communities.

295. (C) Maintaining soil fertility and health.
Decomposed plant and animal matter forms a critical part of the soil system. This organic material is essential for providing nutrients to plants and supporting a healthy population of soil microbes. By improving the soil's ability to hold moisture and maintain its structure, organic matter ensures the long-term fertility and biological productivity of the land.

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(D) The operation of nuclear power plants.

57. Arrange the following solid waste management techniques in a hierarchical order, from most preferred to least preferred.
(a) Disposal
(b) Prevention
(c) Recycling/Composting
(d) Energy Recovery
Choose the correct sequence:
(A) a, d, c, b
(B) b, c, d, a
(C) c, d, a, b
(D) b, d, c, a

58. What is a major component of fly ash, making it useful in cement and brick manufacturing?
(A) Silica, alumina, and iron oxides
(B) Unburnt carbon
(C) Heavy metals like mercury and cadmium
(D) Organic biodegradable matter

59. Which of the following is a key environmental consequence of improper plastic waste management?
(A) Soil enrichment due to biodegradation.
(B) Reduction in greenhouse gas emissions.
(C) Generation of clean energy.
(D) Contamination of marine environments and harm to aquatic life.

60. All of the following are methods for the utilisation of fly ash EXCEPT:
(A) Manufacturing Portland Pozzolana Cement (PPC).
(B) As a nutritional supplement for livestock.
(C) As a soil conditioner in agriculture.
(D) Construction of roads and embankments.

61. Which of the following is the most effective long-term solution for managing plastic waste?
(A) Burying all plastic waste in landfills.
(B) Burning all plastic waste in open fields.
(C) Reducing the consumption of single-use plastics and promoting recycling.
(D) Dumping plastic waste into oceans.

62. Consider the following potential health impacts associated with informal e-waste recycling:
(a) Respiratory problems from inhaling toxic fumes.
(b) Neurological damage from lead and mercury exposure.
(c) Skin diseases from contact with corrosive chemicals.
(d) Cancer due to exposure to carcinogens like dioxins.
(e) Improved cardiovascular health.
Which of the above statements are correct?
(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (c), and (e) only
(D) (a), (b), and (e) only

63. The process of using microorganisms (usually fungi and bacteria) to break down contaminants in hazardous waste is known as:
(A) Bioremediation
(B) Incineration
(C) Solidification
(D) Precipitation

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64. What is the primary function of a daily cover in a sanitary landfill?
(A) To provide nutrients for waste decomposition.
(B) To prevent waste from blowing away, control odors, and deter pests.
(C) To increase the permeability of the landfill.
(D) To act as the main liner for preventing leachate leakage.

65. Match the waste types in List I with the primary constituents of concern in List II.
List I: (Specific Waste Type)
P. E-waste
Q. Fly ash
R. Plastic waste
S. Biomedical waste
List II: (Primary Constituent of Concern)
1. Pathogens and sharps
2. Non-biodegradable polymers
3. Heavy metals (e.g., Lead, Mercury)
4. Silica and Alumina
Choose the correct answer from the options given below:
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

66. What does the term 'biomethanation' specifically refer to in the context of waste management?
(A) The production of methane gas through anaerobic digestion of organic waste.
(B) The conversion of waste into methane using high-temperature thermal processes.
(C) The capture of naturally occurring methane from swamps.
(D) The use of methane as a fuel for collection vehicles.

67. Which of the following is an example of direct manufacture of a product from solid waste?
(A) Exporting plastic scrap to another country.
(B) Melting down aluminum cans to produce aluminum ingots.
(C) Collecting paper for repulping at a paper mill.
(D) Using crushed glass as an aggregate in asphalt (glassphalt).

68. Consider the following statements about vermicomposting:
(a) It is an aerobic decomposition process.
(b) It utilizes specific species of earthworms.
(c) The end product is called vermicast.
(d) It is only suitable for inorganic waste.
Which of the above statements are correct?
(A) (a) and (d) only
(B) (b) and (c) only
(C) (a), (b) and (c) only
(D) (b), (c) and (d) only

69. In a Stationary Container System (SCS), what is the primary action performed by the collection vehicle at the collection point?
(A) It picks up the full container and replaces it with an empty one.
(B) It hauls the container to the landfill and returns it.
(C) It mechanically lifts and empties the container's contents into its own body.
(D) It manually sorts the waste inside the container before collection.

70. The key difference between composting and biomethanation is that composting is an ____ process, while biomethanation is an ____ process.
(A) anaerobic; aerobic
(B) aerobic; anaerobic
(C) thermal; biological
(D) chemical; physical

71. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The layout of solid waste collection routes needs careful planning to be efficient.
Reason (R) : An optimized collection route minimizes travel time, fuel consumption, and operational costs while ensuring complete coverage of the service area.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

72. The presence of which element, determined during ultimate analysis, is a major concern for potential acid rain contribution if the waste is incinerated without proper controls?
(A) Sulphur
(B) Carbon
(C) Hydrogen
(D) Nitrogen

73. Which of the following is a type of hazardous waste?
(A) Waste paper from an office
(B) Vegetable peels from a kitchen
(C) Expired pesticides from a farm
(D) Sawdust from a carpentry shop

74. Given the following statements:
Statement I : Plastic waste is a major cause of soil and water pollution because it is largely non-biodegradable.
Statement II : The management of plastic waste is simplified by the fact that all plastics are easily and economically recyclable.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

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75. The process of using chemical agents to cause dissolved hazardous contaminants in a liquid waste to form insoluble solid particles is known as:
(A) Neutralization
(B) Stabilization
(C) Incineration
(D) Precipitation

76. What is a primary advantage of converting municipal solid waste into fuel pellets?
(A) It increases the moisture content of the waste.
(B) It produces a densified, uniform fuel with a higher calorific value per unit mass than raw waste.
(C) It completely eliminates the need for air pollution control during combustion.
(D) The process requires no energy input.

77. Which of the following correctly identifies an incorrect statement regarding the incineration of solid waste?
(A) Incineration significantly reduces the volume of waste.
(B) Energy in the form of heat or electricity can be recovered from incineration.
(C) The ash produced from incineration is non-toxic and can be used for any purpose.
(D) Proper air pollution control systems are essential for modern incinerators.

78. The term 'pozzolanic activity', relevant to fly ash utilisation, refers to its ability to:
(A) Generate heat when mixed with organic matter.
(B) Absorb large quantities of heavy metals.
(C) Decompose into simple organic compounds.
(D) React with calcium hydroxide in the presence of water to form compounds with cementitious properties.

79. In the context of waste management, 'source reduction' is a strategy that aims to:
(A) Reduce the amount of waste generated at its source.
(B) Separate waste materials at the disposal site.
(C) Reduce the volume of waste through compaction.
(D) Treat waste at the source of generation.

80. Which of the following is NOT a typical source of plastic waste?
(A) Packaging materials
(B) Food scraps and yard trimmings
(C) Discarded consumer goods
(D) Automotive components

81. The main gaseous products of the complete combustion of municipal solid waste (composed of C, H, O) are:
(A) Methane and hydrogen
(B) Carbon dioxide and water vapor
(C) Carbon monoxide and water
(D) Sulphur dioxide and nitrogen oxides

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82. Consider the following methods for the disposal of solid and/or hazardous waste:
(a) Recycling
(b) Sanitary Landfilling
(c) Composting
(d) Secure Landfilling
(e) Incineration (Residue disposal)
Which of the above are considered methods for final disposal?
(A) (a), (c), and (d) only
(B) (b), (d), and (e) only
(C) (a), (b), and (c) only
(D) (c), (d), and (e) only

83. What is the main purpose of a leachate collection system in a sanitary landfill?
(A) To collect rainwater from the surface of the landfill.
(B) To inject water into the landfill to speed up decomposition.
(C) To gather the contaminated liquid from within the landfill for treatment.
(D) To create a barrier to prevent gas from escaping.

84. The process of stabilization of hazardous waste often involves mixing the waste with additives like cement, fly ash, or lime. What is the primary objective of this?
(A) To increase the volume of the waste.
(B) To make the waste more acidic.
(C) To prepare the waste for biological treatment.
(D) To chemically bind the hazardous constituents, reducing their leachability.

85. Match the terms in List I with the associated concepts in List II.
List I: (Term)
P. Vermicast
Q. Leachate
R. RDF
S. Dioxin
List II: (Associated Concept)
1. Landfill pollution
2. Incineration byproduct
3. Energy recovery fuel
4. Vermicomposting product
Choose the correct answer from the options given below:
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-2, R-3, S-1
(D) P-2, Q-3, R-1, S-4

86. The classification of e-waste can be based on its composition. Which category of materials found in e-waste includes lead, mercury, and cadmium?
(A) Precious metals
(B) Hazardous or toxic materials
(C) Ferrous metals
(D) Plastics and polymers

87. Which of the following is a consequence of plastic waste is incorrect?
(A) It can cause entanglement and ingestion issues for wildlife.
(B) It can break down into microplastics, which can enter the food chain.
(C) It can clog drainage systems, leading to flooding.
(D) It enhances soil fertility and water retention capacity.

88. Consider the following statements about landfill gas:
(a) It is primarily composed of methane and carbon dioxide.
(b) It is generated by the aerobic decomposition of organic waste.
(c) It can be collected and used as a source of energy.
(d) Methane, a component of landfill gas, is a potent greenhouse gas.
Which of the above statements are correct?
(A) (a), (c) and (d) only
(B) (a), (b) and (c) only
(C) (b) and (d) only
(D) (a) and (b) only

89. A waste sample is found to be aqueous with a pH of 1.5. According to hazardous waste characteristics, this waste is classified as:
(A) Reactive
(B) Ignitable
(C) Corrosive
(D) Toxic

90. In waste management, the 3Rs hierarchy is often expanded. Which of the following represents a more comprehensive hierarchy, typically in the correct order of preference?
(A) Reduce, Reuse, Recycle, Recover, Dispose
(B) Dispose, Recover, Recycle, Reduce, Reuse
(C) Recycle, Reuse, Reduce, Recover, Dispose
(D) Recover, Reduce, Dispose, Reuse, Recycle

91. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Secure landfills for hazardous waste require more stringent design and monitoring standards than sanitary landfills for municipal waste.
Reason (R) : Hazardous waste poses a greater long-term threat to groundwater and public health, necessitating double liners, and more extensive leachate and gas management systems.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

92. Which waste management technique is based on the principle of anaerobic digestion?
(A) Incineration
(B) Biomethanation
(C) Composting
(D) Open dumping

93. The ultimate analysis of a solid waste sample is performed to determine its:

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(A) Moisture, volatile matter, and ash content
(B) Density and particle size
(C) Elemental composition (C, H, O, N, S)
(D) Calorific value and ignitability

94. What is the primary negative consequence of disposing of e-waste in an uncontrolled manner, such as in open dumps?
(A) It improves the aesthetic quality of the area.
(B) It provides a valuable source of nutrients for the local ecosystem.
(C) It rapidly biodegrades into harmless components.
(D) It leads to the leaching of heavy metals and other toxic substances into the soil and water.

95. In the context of hazardous waste, 'reactivity' refers to the property of a waste to:
(A) Be dangerously unstable, react violently with water, or generate toxic gases.
(B) Wear away steel at a specified rate.
(C) Catch fire under certain conditions.
(D) Be harmful or fatal when ingested or absorbed.

96. Which of the following is a major utilisation pathway for fly ash in the construction industry?
(A) As a decorative coating for buildings
(B) As a partial replacement for cement in concrete
(C) As a primary material for electrical wiring
(D) As a transparent material for windows

97. Given the following statements:
Statement I : Vermicomposting is a thermophilic process, reaching temperatures above 60°C.
Statement II : The process of vermicomposting relies on microorganisms and earthworms working at mesophilic temperatures.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

98. The primary role of a transfer station in solid waste management is to:
(A) Improve the efficiency of waste transportation to distant disposal sites.
(B) Act as a final disposal site.
(C) Serve as a materials recovery facility only.
(D) Treat hazardous waste before disposal.

99. Which of the following best describes the principle of oxidation-reduction in hazardous waste treatment?
(A) Adding an acid or base to neutralize the waste.
(B) Separating solids from a liquid waste stream.
(C) Changing the oxidation state of a substance to convert it into a less toxic form.
(D) Encapsulating the waste in a solid matrix like cement.

100. In India, the solid waste management rules emphasize a hierarchy that prioritizes:
(A) Land filling as the first option
(B) Incineration for all types of waste
(C) Exporting waste to other countries
(D) Source segregation and resource recovery

101. A city implemented the following steps for its new waste management system. Arrange them in a logical chronological order of material flow.
(a) Waste is transported to a materials recovery facility (MRF).
(b) Residents segregate waste into dry and wet components.
(c) Recyclables are sorted, baled, and sent to recycling industries.
(d) Collection vehicles pick up the segregated waste.
Choose the correct sequence:
(A) b, d, a, c
(B) a, b, d, c
(C) d, c, b, a
(D) b, a, d, c

102. Which of these is a significant disadvantage of incinerating solid waste?
(A) It increases the volume of waste by over 500%.
(B) It has a high capital cost and requires skilled operation.
(C) It requires a very large land area compared to a landfill.
(D) It cannot handle a continuous flow of waste.

103. The term 'garbage' is most accurately defined as:
(A) All non-combustible waste materials.

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density.
(D) Remove all moisture from the waste.

122. Which of the following is a key difference between a sanitary landfill and a secure landfill?
(A) Secure landfills have more stringent containment features like double liners and enhanced monitoring systems.
(B) Secure landfills are used for municipal waste, while sanitary landfills are for hazardous waste.
(C) Sanitary landfills do not require a daily cover, but secure landfills do.
(D) There is no difference; the terms are interchangeable.

123. Given the following statements about composting:
Statement I : A very low C/N ratio (e.g., 10:1) in the initial compost mixture leads to the loss of nitrogen as ammonia gas.
Statement II : A very high C/N ratio (e.g., 100:1) slows down the composting process because of insufficient nitrogen for microbial growth.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

124. In the hierarchy of e-waste management, what is the most preferred option?
(A) Incineration
(B) Prevention and Reuse
(C) Landfilling
(D) Recycling

125. Match the processes in List I with the key inputs or agents in List II.
List I: (Process)
P. Vermicomposting
Q. Biomethanation
R. Incineration
S. Neutralization
List II: (Key Input/Agent)
1. High Temperature and Oxygen
2. Acid or Alkali
3. Anaerobic Microorganisms
4. Earthworms
Choose the correct answer from the options given below:
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-2, S-1
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

126. A container system where the container is left at the point of waste generation and emptied periodically by a collection vehicle is known as:
(A) A Hauled Container System (HCS)
(B) A Pneumatic System
(C) A Manual Collection System
(D) A Stationary Container System (SCS)

127. The term proximate analysis in the context of solid waste refers to the determination of:
(A) The percentages of moisture, volatile matter, fixed carbon, and ash.
(B) The proximity of the waste to the disposal site.
(C) The elemental composition of the waste.
(D) The approximate number of recyclable items in a waste sample.

128. Consider the following as potential components of a comprehensive e-waste management system:
(a) Collection mechanisms like take-back schemes.
(b) Environmentally sound dismantling and recycling facilities.
(c) A policy framework for Extended Producer Responsibility (EPR).
(d) Public awareness campaigns.
(e) Open burning as the primary disposal method.
Which of the above statements are correct?
(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (c), and (e) only
(D) (a), (b), and (e) only

129. What is a primary purpose of a gas collection system in a modern sanitary landfill?
(A) To inject oxygen into the waste mass to promote aerobic decomposition.
(B) To prevent the uncontrolled release of methane and other gases, and potentially use it for energy.
(C) To supply gas to the surrounding neighborhood for cooking.
(D) To increase the internal pressure of the

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(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

112. The term 'e-waste' is an abbreviation for:
(A) Environmental Waste
(B) Electronic Waste
(C) Economic Waste
(D) Ecological Waste

113. One of the main challenges in plastic waste management is:
(A) The extremely high value of all types of post-consumer plastic.
(B) The wide variety of polymer types, which often require separation for effective recycling.
(C) The rapid rate at which plastic biodegrades in landfills.
(D) The lack of any technology to convert plastic waste to energy.

114. In hazardous waste management, the process of 'stabilization' aims to:
(A) Chemically reduce the hazard potential by converting constituents to less soluble or toxic forms.
(B) Physically bind or enclose the waste in a stable mass.
(C) Destroy the hazardous constituents through combustion.
(D) Separate the hazardous materials from non-hazardous ones.

115. Consider the following statements regarding the characteristics of solid waste:
(a) Physical characteristics include density and moisture content.
(b) Chemical characteristics include pH and calorific value.
(c) Proximate analysis determines the percentage of C, H, and O.
(d) The composition of waste is independent of lifestyle and economic conditions.
Which of the above statements are correct?
(A) (a) and (b) only
(B) (c) and (d) only
(C) (a), (b) and (c) only
(D) (a), (b) and (d) only

116. Which process is represented by the conversion of Cr(VI) to the less toxic Cr(III) in an industrial wastewater stream?
(A) Neutralization
(B) Precipitation
(C) Solidification
(D) Reduction

117. What is the most appropriate description of a 'sanitary landfill'?
(A) A pit where waste is dumped and left uncovered.
(B) Site where organic waste is converted into compost.
(C) An engineered facility for disposing of solid waste on land in a manner that protects the environment.
(D) A facility for the high-temperature combustion of waste.

118. Which of the following is NOT a source of fly ash?
(A) Coal-fired power stations
(B) Biomethanation plants
(C) Some types of industrial furnaces
(D) MSW incinerators

119. The layout of collection routes is a sub-component of which major functional element of solid waste management?
(A) Waste generation
(B) Waste handling and separation at source
(C) Disposal
(D) Collection and transportation

120. Which statement correctly identifies a health impact of hazardous waste?
(A) Exposure to asbestos can lead to lung diseases.
(B) Ingesting biodegradable food waste improves digestion.
(C) Contact with fly ash always results in immediate skin burns.
(D) Proximity to a well-managed sanitary landfill strengthens the immune system.

121. The main purpose of shredding solid waste before landfilling or processing is to:
(A) Increase its calorific value.
(B) Separate the hazardous components.
(C) Improve its homogeneity and increase its

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141. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Sanitary landfilling remains a widely used method for solid waste disposal, especially in developing countries.

Reason (R) : It is technologically complex and has the highest operational cost among all disposal options.

In light of the above statements, choose the most appropriate answer from the options given below:

(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

142. The process that uses high temperatures (in the presence of oxygen) to destroy the organic components of waste is:

(A) Composting
(B) Biomethanation
(C) Landfilling
(D) Incineration

143. Which of the following is a major challenge associated with the management of fly ash?

(A) The large quantities generated and the potential for leaching of heavy metals.
(B) Its rapid biodegradation.
(C) Its high calorific value, which poses a fire risk.
(D) Its high commercial value, leading to theft.

144. In a waste-to-energy facility, what is the primary purpose of recovering materials like metals before incineration?

(A) To increase the total volume of waste to be burned.
(B) To prevent damage to the incinerator and to recover valuable resources.
(C) To increase the moisture content of the waste.
(D) To reduce the overall calorific value of the waste.

145. The calorific value of solid waste, a key parameter for incineration, is determined in which type of analysis?

(A) Proximate analysis
(B) Specific chemical characteristic testing
(C) Ultimate analysis
(D) Standard physical characteristic testing

146. Which hazardous waste characteristic is defined by having a flash point below 60°C?

(A) Ignitability
(B) Corrosivity
(C) Reactivity
(D) Toxicity

147. A transfer station is an intermediate facility in a solid waste management system. What is its main function?

(A) It is the final destination for all the city's waste.
(B) It is a place for the permanent storage of hazardous waste.
(C) It facilitates the transfer of waste from smaller collection vehicles to larger transport vehicles.
(D) It is a facility dedicated solely to composting organic waste.

148. Consider the following potential sources of e-waste:

(a) Discarded refrigerators and air conditioners.
(b) Used mobile phones and computers.
(c) Spent fluorescent lamps.
(d) Discarded televisions.
(e) Kitchen food scraps.

Which of the above are significant sources?

(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (c), and (e) only
(D) (a), (b), and (e) only

149. The process of converting organic matter into a humus-like, stable material through the action of microorganisms in the presence of oxygen is:

(A) Incineration
(B) Composting
(C) Pyrolysis
(D) Biomethanation

150. Match the waste management hierarchy levels in List I with the example actions in List II.

List I: (Waste Management Hierarchy)

P. Reduce
Q. Reuse

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landfill for better compaction.

130. The treatment of cyanide-containing waste often involves a chemical process to convert the toxic cyanide (CN-) into less toxic cyanate (CNO-). This is an example of:
(A) Oxidation
(B) Precipitation
(C) Neutralization
(D) Solidification

131. Which of the following facilities, often found in MSW, is most desirable for a waste-to-energy incineration plant?
(A) Wet food waste with high moisture content.
(B) Glass bottles and jars.
(C) Dry paper and plastics with high calorific value.
(D) Construction and demolition debris.

132. The process of using earthworms to degrade organic solid waste is called:
(A) Composting
(B) Biomethanation
(C) Incineration
(D) Vermicomposting

133. What is the main reason for the failure of many composting plants in developing countries that handle mixed municipal solid waste?
(A) Lack of sufficient sunlight for microbial growth.
(B) The low percentage of organic matter in the waste stream.
(C) The high content of inert materials and plastics in unsorted waste.
(D) The high cost of specialized earthworms required for the process.

134. Which of the following is a physical method of hazardous waste treatment?
(A) Incineration
(B) Neutralization
(C) Oxidation
(D) Solidification

135. Consider the following statements about the utilisation of fly ash:
(a) It is used in the manufacturing of cement.
(b) It can be used as a soil stabilizer for road construction.
(c) It is a primary ingredient in high-nutrition animal feed.
(d) It can be used for manufacturing bricks and blocks.
Which of the above statements are correct?
(A) (a), (b) and (c) only
(B) (b), (c) and (d) only
(C) (a), (b) and (d) only
(D) (a) and (c) only

136. The uncontrolled combustion of PVC (polyvinyl chloride) plastic waste is particularly hazardous because it can release:
(A) Dioxins and furans
(B) Pure oxygen
(C) Methane
(D) Nitrogen gas

137. Which solid waste component has the highest density in its typical loose state?
(A) Paper
(B) Plastics
(C) Glass and ceramics
(D) Yard waste

138. The primary objective of the stabilization process in hazardous waste management is to:
(A) Render the waste non-hazardous or less hazardous by chemical reactions.
(B) Reduce the volume of the waste.
(C) Separate waste into different components.
(D) Increase the energy content of the waste.

139. Given the following statements:
Statement I : Laying out collection routes in loops is a recommended practice.
Statement II : Looped routes generally minimize the non-collection distance, known as dead-head time.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

140. Which of the following is NOT a typical characteristic of hazardous waste?
(A) Corrosivity
(B) High nutrient value for agriculture
(C) Ignitability
(D) Reactivity

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(B) Waste materials generated from construction and demolition.
(C) Discarded paper, cardboard, and plastics.
(D) Putrescible wastes, primarily from food preparation and consumption.

104. Which of the following pairs is incorrectly matched?
(A) Biomethanation - Requires a constant supply of oxygen.
(B) Proximate Analysis - Determines moisture content.
(C) Ultimate Analysis - Determines carbon content.
(D) Composting - Aerobic biological process.

105. Match the hazardous waste treatment processes in List I with their mechanisms in List II.
List I: (Hazardous Waste Treatment)
P. Neutralization
Q. Precipitation
R. Solidification
S. Oxidation
List II: (Mechanism)
1. Encapsulation in a solid matrix
2. Removal of an electron from a hazardous species
3. Addition of an acid or a base to adjust pH
4. Transformation of a dissolved substance into an insoluble solid
Choose the correct answer from the options given below:
(A) P-1, Q-2, R-4, S-3
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-1, S-2

106. A key component of a Hauled Container System (HCS) for commercial waste is:
(A) A large roll-off or drop-box container that is transported to the disposal site.
(B) A small bin placed on the cursor for manual loading.
(C) A stationary compactor that is emptied on-site.
(D) A system of pneumatic tubes to transport waste.

107. The composition of fly ash is most similar to:
(A) Rich topsoil
(B) Composted organic matter
(C) Raw sewage sludge
(D) Volcanic ash

108. Consider the following potential consequences of the improper disposal of plastic waste:
(a) Choking of drainage systems.
(b) Ingestion by marine and terrestrial animals.
(c) Formation of microplastics.
(d) Release of toxic chemicals from additives.
(e) Rapid biodegradation and soil enrichment.
Which of the above statements are correct?
(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (c), and (e) only
(D) (a), (b), and (e) only

109. What is the primary environmental concern related to landfill gas?
(A) It is highly corrosive and destroys the landfill liner.
(B) It has a pleasant smell that attracts wildlife.
(C) Its main component, methane, is a potent greenhouse gas.
(D) It consists mainly of oxygen, creating a fire hazard.

110. Which statement accurately describes Refuse Derived Fuel (RDF)?
(A) It is the raw, unprocessed municipal solid waste.
(B) It is a fuel produced from the non-combustible fraction of MSW.
(C) It is the liquid leachate collected from a landfill.
(D) It is a segregated, high-calorific value fraction of processed MSW, often pelletized.

111. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The C/N ratio is a critical parameter for successful composting.
Reason (R) : Microorganisms require carbon for energy and nitrogen for protein synthesis; an optimal ratio ensures efficient decomposition without odors.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).

R. Recycle
S. Recover

List II: (Example Action)
1. Using refillable water bottles
2. Converting non-recyclable waste into energy
3. Using less packaging for products
4. Processing used paper into new paper products

Choose the correct answer from the options given below:
(A) P-1, Q-3, R-4, S-2
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

151. Which of the following is a biological method for solid waste processing?
(A) Incineration
(B) Shredding
(C) Landfilling
(D) Vermicomposting

152. Which of the following statements about the incineration of solid waste is incorrect?
(A) It is a completely pollution-free process.
(B) It reduces the volume of waste by about 85-90%.
(C) It can be used to generate electricity.
(D) It requires high capital investment.

153. A Hauled Container System (HCS) is generally more economical than a Stationary Container System (SCS) when:
(A) The waste generation rate at each pickup location is very low.
(B) The pickup locations are very close to each other.
(C) The volume of waste generated per pickup is large, justifying the transport of the entire container.
(D) The city has severe traffic congestion.

154. What is the primary environmental concern with the leachate generated from landfills?
(A) It can contaminate groundwater and surface water.
(B) It is a valuable source of clean water.
(C) It helps in the growth of forests on top of the landfill.
(D) It has a pleasant odour.

155. Which of these is a major component in the composition of fly ash?
(A) Methane
(B) Plastic polymers
(C) Pathogenic bacteria
(D) Silica (silicon dioxide)

156. Arrange the stages of anaerobic digestion that occur during biomethanation in the correct chronological order.
(a) Acidogenesis
(b) Methanogenesis
(c) Hydrolysis
(d) Acetogenesis

Choose the correct sequence:
(A) a, c, d, b
(B) c, d, a, b
(C) c, a, d, b
(D) a, d, c, b

157. The management of plastic waste is complex. Which of the following is a primary reason?
(A) All plastics are toxic and cannot be handled.
(B) Plastics are valuable and are never discarded.
(C) The diversity of plastic types makes sorting for recycling difficult.
(D) Plastic decomposes very quickly, releasing harmful gases.

158. The primary difference between solidification and stabilization of hazardous waste is that:
(A) Solidification is a chemical process, while stabilization is a physical process.
(B) Solidification is only for liquid wastes, while stabilization is for solid wastes.
(C) There is no significant difference; the terms are synonymous.
(D) Solidification encapsulates the waste, while stabilization aims to make it chemically less harmful.

159. Which of the following is NOT a source of hazardous waste?
(A) A well-managed composting facility processing only food and yard waste
(B) Metal plating industries
(C) Households (e.g., batteries, paints)
(D) Hospitals

160. Consider the following statements about e-waste:

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(a) It is one of the fastest-growing waste streams.
(b) Informal recycling can release toxic substances like lead and mercury.
(c) It contains valuable metals such as gold, silver, and copper.
(d) It is completely harmless and can be disposed of with regular municipal waste.

Which of the above statements are correct?
(A) (a) and (d) only
(B) (b), (c) and (d) only
(C) (a), (b) and (c) only
(D) (a) and (b) only

161. In the context of solid waste collection, what does 'container system' refer to?
(A) The type of vehicle used for collection.
(B) The system of bins or containers used for storing waste at the source before collection.
(C) The software used for routing the collection vehicles.
(D) The structure of the landfill where waste is contained.

162. Proximate analysis is used to determine the percentages of four components in solid waste. Which of the following is one of them?
(A) Volatile Matter
(B) Carbon
(C) Hydrogen
(D) Oxygen

163. The process of burning solid waste in a controlled environment to generate electrical energy is an example of:
(A) Materials recovery
(B) Biological recovery
(C) Energy recovery
(D) Chemical recovery

164. What is the primary mechanism of vermicomposting?
(A) High-temperature thermal degradation of waste.
(B) Anaerobic digestion of waste by bacteria to produce biogas.
(C) Chemical oxidation of waste using strong agents.
(D) The combined action of earthworms and microorganisms to decompose organic matter.

165. Which hazardous waste treatment method would be most suitable for treating a large volume of acidic industrial effluent (pH=$_2$.0)?
(A) Incineration
(B) Solidification
(C) Neutralization
(D) Precipitation

166. Which statement accurately describes a major consequence of plastic waste in the marine environment?
(A) It serves as a primary food source for large marine mammals.
(B) It can be ingested by marine animals, causing injury or death, and can break down into microplastics.
(C) It rapidly dissolves and disperses without a trace.
(D) It enhances coral reef growth by providing a stable structure.

167. The utilization of fly ash in manufacturing bricks is an example of:
(A) Waste disposal
(B) Waste reduction
(C) Waste generation
(D) Waste recycling and reuse

168. In designing collection routes, why should U-turns be avoided as much as possible?
(A) They are difficult for drivers to execute and can be unsafe.
(B) They are considered non-collection activities and are time-consuming.
(C) They are illegal on most streets.
(D) Both (A) and (B).

169. What is the main health concern related to the informal handling of e-waste?
(A) Risk of electric shock from powered-on devices.
(B) The unpleasant appearance of the waste.
(C) Exposure to toxic substances like heavy metals and flame retardants.
(D) The noise generated during dismantling.

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170. Which of the following is an example of a Hauled Container System?
(A) A large roll-off container at a construction site that is transported to a landfill when full.

(B) A curbside bin that is emptied by a front-loading truck.
(C) A shared neighborhood container that is emptied on-site weekly.
(D) A public litter bin emptied manually by sanitation workers.

171. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Biomethanation of solid waste is considered a method for both waste treatment and energy recovery.
Reason (R) : The process converts the biodegradable fraction of waste into methane-rich biogas, which is a combustible fuel, and a digested slurry that can be used as manure.
In light of the above statements, choose the most appropriate answer from the options given below:
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

172. The final cover of a sanitary landfill has a primary function to:
(A) Encourage rapid settlement of the waste.
(B) Minimize water infiltration and support surface vegetation.
(C) Maximize the generation of landfill gas.
(D) Keep the waste accessible for future mining.

173. What property of fly ash makes it a valuable addition to concrete?
(A) Its black color
(B) Its high carbon content
(C) Its pozzolanic properties
(D) Its biodegradable nature

174. Given the following statements:
Statement I : All types of plastics are easily recyclable into high-quality products.
Statement II : The presence of different additives, colors, and polymer types makes large-scale plastic recycling challenging.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

175. The ultimate analysis of solid waste is essential for designing which of the following facilities?
(A) An incinerator
(B) A composting plant
(C) A vermicomposting shed
(D) A materials recovery facility

176. Which of the following waste types is NOT generally considered hazardous?
(A) Spent solvents from a cleaning process
(B) Waste paper and cardboard
(C) Discarded car batteries
(D) Residues from pesticide manufacturing

177. The treatment method 'precipitation' is most effective for removing what type of contaminants from a liquid hazardous waste stream?
(A) Dissolved organic compounds
(B) Dissolved heavy metals
(C) Suspended solids
(D) Pathogenic bacteria

178. Consider the following as potential components of a comprehensive e-waste management system:
(a) Collection mechanisms like take-back schemes.
(b) Environmentally sound dismantling and recycling facilities.
(c) A policy framework for Extended Producer Responsibility (EPR).
(d) Public awareness campaigns.
(e) Open burning as the primary disposal method.
Which of the above statements are correct?
(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (b), (c), and (d) only
(D) (a), (c), and (e) only

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179. The term 'putrescible' refers to waste that is:
(A) Highly flammable.
(B) Non-combustible.
(C) Likely to decompose rapidly and cause odors.
(D) Toxic upon ingestion.

(b) Source Reduction
(c) Landfilling
(d) Reuse
Choose the correct sequence:
(A) b, d, a, c
(B) d, b, c, a
(C) c, a, d, b
(D) b, a, d, c

222. The primary cause of concern regarding plastic waste in the environment is its:
(A) High density
(B) High nutritional value
(C) High solubility in water
(D) Non-biodegradability and persistence

223. What is the purpose of adding a neutralizing agent like lime to an acidic hazardous waste stream?
(A) To raise the pH towards a neutral value (around 7).
(B) To increase its acidity.
(C) To make the waste more solid.
(D) To increase its flammability.

224. Which of the following is NOT a method for handling and disposal of e-waste?
(A) Refurbishing and reusing
(B) Land application as a soil fertilizer
(C) Controlled recycling for metal recovery
(D) Secure landfilling of non-recyclable parts

225. Consider the following statements regarding the management of plastic waste:
(a) Source reduction involves using less plastic packaging.
(b) All types of plastic can be mixed together for high-quality recycling.
(c) Co-processing in cement kilns can be a method for energy recovery from non-recyclable plastics.
(d) Plastic waste enhances the aesthetic value of oceans and landscapes.
Which of the above statements are correct?
(A) (a) and (c) only
(B) (b) and (d) only
(C) (a), (b) and (c) only
(D) (c) and (d) only

226. 'Leachate' in the context of a landfill is:
(A) A contaminated liquid that seeps through the waste.
(B) A gas produced by anaerobic decomposition.
(C) The solid residual material after decomposition.
(D) The daily soil cover applied to the waste.

227. In solid waste analysis, the energy content is a key parameter. This is determined as part of the:
(A) Proximate analysis
(B) Ultimate analysis
(C) Chemical characteristics
(D) Physical characteristics

228. The term 'biomethanation' refers to the:
(A) Generation of compost under aerobic conditions.
(B) Burning of biomass to produce energy.
(C) Capture of methane from coal mines.
(D) Production of methane gas from organic material under anaerobic conditions.

229. Which of the following is a common application for fly ash?
(A) As a food additive
(B) In cosmetics
(C) In the manufacturing of bricks and cement
(D) As a clothing material

230. The most detrimental impact of plastic bags on urban infrastructure is:
(A) Improving the strength of road surfaces.
(B) Providing a source of raw material for artists.
(C) Decomposing into rich organic matter.
(D) Clogging drains and sewer systems, leading to flooding.

231. The process of converting hazardous constituents into a non-hazardous or less-hazardous form through chemical reactions is called:
(A) Transportation
(B) Compaction
(C) Collection
(D) Stabilization

232. Given the following statements:
Statement I : The Hauled Container System (HCS) is most efficient for locations that generate large volumes of waste, such as construction sites.
Statement II : The Stationary Container System

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190. Consider the following statements about sanitary land filling:
(a) It is an engineered method of waste disposal.
(b) It must have a liner to prevent groundwater contamination.
(c) It requires a daily cover to control pests and odors.
(d) It does not produce any greenhouse gases.
Which of the above statements are correct?
(A) (a), (b) and (d) only
(B) (b) and (c) only
(C) (a), (b) and (c) only
(D) (a) and (d) only

191. The primary purpose of proximate analysis of solid waste is to evaluate its suitability for:
(A) Thermal processes like combustion
(B) Biological treatment processes
(C) Chemical neutralization
(D) Material recycling

192. Which of the following is NOT a characteristic property used to identify hazardous waste?
(A) Ignitability
(B) Density
(C) Corrosivity
(D) Reactivity

193. The biomethanation process is carried out by microorganisms under what conditions?
(A) Aerobic conditions
(B) Anaerobic conditions
(C) High-temperature and high-pressure conditions
(D) The presence of sunlight and water

194. What is the most appropriate management option for non-biodegradable, non-recyclable plastic waste with high calorific value?
(A) Use as a fuel in energy recovery facilities (e.g., cement kilns).
(B) Composting
(C) Dumping in rivers.
(D) Use as agricultural mulch.

195. Given the following statements:
Statement I : Fly ash can be utilized in the reclamation of wastelands and filling of low-lying areas.
Statement II : The use of fly ash in agriculture is always beneficial, regardless of its heavy metal content.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

196. The main objective of optimizing a solid waste collection route is to:
(A) Maximize the distance traveled by the collection vehicle.
(B) Ensure the route passes through the most scenic parts of the city.
(C) Visit each collection point multiple times in one trip.
(D) Minimize the total time and distance for the collection round trip.

197. Which of these is a likely health impact of long-term exposure to lead from informal e-waste recycling?
(A) Improved memory
(B) Neurological and developmental damage
(C) Stronger bones
(D) Enhanced vision

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198. The final step in the management of incinerator ash and residues from hazardous waste treatment is typically:
(A) Disposal in a secure landfill
(B) Sale as fertilizer
(C) Discharge into the nearest water body
(D) Reuse as construction material without any testing

199. What does 'Refuse Derived Fuel' (RDF) primarily consist of?
(A) The organic fraction of waste prepared for composting.
(B) The inert materials, like glass and metal, separated from waste.
(C) The liquid leachate collected from a landfill.
(D) The combustible components of municipal solid waste, such as plastic and paper.

200. Which of the following pairs is correctly matched?
(A) Vermicomposting - Involves earthworms
(B) Composting - Anaerobic process
(C) Incineration - Biological process
(D) Land filling - Energy generation process

180. Match the waste components in List I with the appropriate management methods in List II.
List I: (Waste Component)
P. Wet food waste
Q. Dry paper and cardboard
R. Discarded tyres
S. Demolition debris
List II: (Appropriate Management Method)
1. Recycling
2. Pyrolysis or use in cement kilns
3. Composting or Biomethanation
4. Crushing and reuse as aggregate
Choose the correct answer from the options given below:
(A) P-1, Q-3, R-4, S-2
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

181. What is the primary goal of creating 'fuel pellets' from solid waste?
(A) To increase the waste's moisture content for better biological treatment.
(B) To separate the metals from the waste stream.
(C) To create a uniform, densified, and easy-to-transport fuel with a consistent heating value.
(D) To prepare the waste for secure landfilling.

182. A major environmental benefit of recycling aluminum cans compared to producing aluminum from bauxite ore is:
(A) A significant reduction in energy consumption.
(B) An increase in mining jobs.
(C) A higher quality of the final aluminum product.
(D) The process generates pure oxygen as a byproduct.

183. The characteristic of hazardous waste known as 'corrosivity' is typically measured by its:
(A) Flash point
(B) Lethal dose (LD50)
(C) Radioactivity
(D) pH level

184. In a sanitary landfill, what is the main purpose of installing a gas venting system?
(A) To safely control the release of methane and other gases produced during decomposition.
(B) To allow oxygen to enter the landfill.
(C) To inject water to accelerate decomposition.
(D) To monitor the temperature of the waste.

185. What is a significant consequence of the non-biodegradable nature of most plastic waste?
(A) It quickly turns into fertile soil.
(B) It provides a long-term food source for microorganisms.
(C) It persists in the environment for hundreds of years.
(D) It dissolves in water, enriching it with nutrients.

186. Which of the following is a primary source of fly ash?
(A) Coal-fired thermal power plants
(B) Residential kitchens
(C) Nuclear power plants
(D) Hydroelectric dams

187. White goods such as refrigerators and washing machines are classified under which broad category of waste?
(A) Agricultural waste
(B) Hazardous waste
(C) Biomedical waste
(D) E-waste or bulky waste

188. In the context of collection route optimization, what is the 'dead-head' time?
(A) The time spent collecting waste.
(B) The time spent traveling from the garage to the start of the route and from the end of the route to the disposal site.
(C) The time spent by the crew during their lunch break.
(D) The time the collection vehicle is stopped in traffic.

189. Which of the following treatment methods physically binds hazardous waste into a solid, monolithic block to reduce contaminant migration?
(A) Neutralization
(B) Incineration
(C) Solidification
(D) Oxidation

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List II: (Category)
1. Polymers
2. Hazardous substance
3. Valuable metal
4. Complex assembly with multiple materials

Choose the correct answer from the options given below:
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-2, R-3, S-1
(D) P-2, Q-3, R-1, S-4

211. What is the primary function of a geomembrane liner in a sanitary landfill?
(A) To act as an impermeable barrier to contain leachate.
(B) To provide structural support to the waste.
(C) To collect landfill gas.
(D) To promote vegetation on the landfill surface.

212. Which of the following is a key advantage of vermicomposting over traditional composting?
(A) It can handle all types of hazardous waste.
(B) It does not require any management of moisture or aeration.
(C) It generates high temperatures that sterilize the waste completely.
(D) It is a much faster process and produces a higher quality compost (vermicast).

213. The heating value of solid waste is a critical parameter for which process?
(A) Composting
(B) Recycling
(C) Incineration
(D) Landfilling

214. Which of the following correctly pairs a hazardous waste characteristic with its description?
(A) Toxicity – harmful or fatal when ingested or absorbed.
(B) Ignitability – can explode under normal conditions.
(C) Corrosivity – has a pH of 7.0.
(D) Reactivity – readily catches fire.

215. The presence of materials like plastics, glass, and metals in municipal solid waste makes which process difficult and inefficient without prior segregation?
(A) Transportation
(B) Compaction
(C) Collection
(D) Composting

216. A city decides to process its MSW to create fuel pellets. This product is a type of:
(A) Refuse Derived Fuel (RDF)
(B) Raw solid waste
(C) Vermicompost
(D) Leachate

217. Which of the following is a major source of e-waste?
(A) Food processing industry
(B) Agricultural residues
(C) Obsolete computers and mobile phones
(D) Packaging from consumer goods

218. The main chemical constituents of fly ash are oxides of:
(A) Silicon, Aluminum, and Iron
(B) Carbon, Hydrogen, and Nitrogen
(C) Sodium, Potassium, and Calcium
(D) Uranium, Plutonium, and Thorium

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219. What is the most significant environmental threat posed by the landfilling of untreated e-waste?
(A) The generation of valuable metals.
(B) The release of pleasant odors.
(C) The rapid biodegradation of electronic components.
(D) The leaching of heavy metals like lead and mercury into groundwater.

220. Which of the following is an example of the 'utilisation' of fly ash?
(A) Disposing it in deep oceans.
(B) Using it as a raw material in cement manufacturing.
(C) Storing it indefinitely in ash ponds.
(D) Mixing it with hazardous chemical waste.

221. Arrange the following waste management methods in the order of their preference according to the waste management hierarchy (most to least preferred).
(a) Incineration with energy recovery

(D) Physically bind the waste in a cement matrix.

243. The primary reason for the high environmental impact of plastic waste is its:
(A) High economic value.
(B) Property of being extremely lightweight.
(C) Durability and resistance to natural degradation processes.
(D) Ability to conduct electricity.

244. In a solid waste collection system, a 'transfer station' serves to:
(A) Increase the number of small trucks traveling to the final disposal site.
(B) Act as a permanent disposal facility.
(C) Separate residential waste from commercial waste.
(D) Reduce overall transport cost by consolidating waste into larger vehicles.

245. Which of the following is a direct consequence of disposing of e-waste, like old CRT monitors, in an unlined landfill?
(A) The soil around the landfill will become more fertile.
(B) The plastic casings will biodegrade within a few weeks.
(C) Lead from the CRT glass can leach into the groundwater.
(D) The e-waste will generate a significant amount of clean energy.

246. The term 'ultimate analysis' of solid waste is used to determine its:
(A) Moisture and ash content.
(B) Elemental composition (C, H, O, N, S, etc.).
(C) Density and porosity.
(D) Calorific value and ignitability.

247. From a waste management perspective, what is the most significant characteristic of fly ash?
(A) Its biodegradability
(B) Its high moisture content
(C) Its organic content
(D) Its pozzolanic nature and fine particle size

248. Incineration is a form of waste treatment that involves:
(A) Controlled combustion at high temperatures.
(B) Biological decomposition.
(C) Compaction and burial.
(D) Decomposition by earthworms.

249. Which of the following represents a source of hazardous waste from households?
(A) Fruit peels
(B) Discarded newspapers
(C) Used batteries and leftover paint
(D) Glass bottles

250. The proper management of plastic waste should prioritize which of the following, according to the waste hierarchy?
(A) Reduction and Reuse
(B) Landfilling
(C) Incineration
(D) Recycling

Direction : Please read the following source carefully.

The domain of solid waste management encompasses a systematic understanding of the waste stream, beginning with its fundamental attributes. Solid waste is broadly categorized based on its types and sources, which can range from residential and commercial to industrial and institutional. The characteristics of this waste are critical for designing effective management systems and include physical, chemical, and biological properties. A key parameter in municipal solid waste planning is the generation rate, which varies significantly with geographic location, economic status, and season. Understanding the components of solid waste, such as food waste, paper, plastics, glass, and metals, is essential for evaluating its potential for recovery and recycling. The analysis of these components can be further refined through proximate and ultimate analyses. Proximate analysis provides insights into the moisture content, volatile matter, fixed carbon, and ash, which is crucial for combustion and biological treatment processes. Ultimate analysis, on the other hand, determines the elemental composition of the waste. A comprehensive grasp of these initial parameters—types, sources, characteristics, generation rates, and components—forms the bedrock upon which all subsequent management strategies, from collection to disposal, are built.

Based on the above source, attempt the following five questions.

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(SCS) is more efficient in densely populated residential areas where waste per household is smaller.
Which of the above statement(s) is/are correct?
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true but Statement II is false.
(D) Statement I is false but Statement II is true.

233. The main difference between composting and vermicomposting lies in the:
(A) Aerobic versus anaerobic nature of the process.
(B) Use of high temperatures in vermicomposting.
(C) Primary agent of decomposition (microorganisms vs. earthworms plus microorganisms).
(D) Final product being liquid in one and solid in the other.

234. In the context of hazardous waste, TCLP is a test method used to determine:
(A) The mobility of toxic contaminants, simulating landfill leaching.
(B) The flash point of a liquid waste.
(C) The pH of an aqueous waste.
(D) The explosive potential of a waste.

235. The purpose of having separate collection streams for different types of e-waste is to:
(A) Make transportation more complicated.
(B) Mix all the waste together at the final disposal site.
(C) Increase the total volume of waste collected.
(D) Facilitate targeted recycling and proper handling of hazardous components.

236. Which of the following is the best description of recycling?
(A) The process of burning waste to recover energy.
(B) The processing of waste materials to make the same or different products.
(C) The final placement of waste in a landfill.
(D) The reduction of waste generated at the source.

237. The 'fixed carbon' content of solid waste, determined by proximate analysis, represents:
(A) The total carbon in the waste.
(B) The carbon present in plastic components.
(C) The non-volatile, combustible material remaining after driving off volatile matter.
(D) The carbon that cannot be burned.

238. What is a primary health concern associated with open burning of mixed solid waste?
(A) Generation of pleasant aromas.
(B) Sterilization of the surrounding soil.
(C) Production of clean energy.
(D) Release of toxic pollutants like dioxins, furans, and particulate matter.

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239. The process of solidification is a hazardous waste treatment method that:
(A) Changes the physical properties of the waste to make it a solid block.
(B) Converts the waste into a gaseous form.
(C) Neutralizes the pH of the waste.
(D) Separates heavy metals through precipitation.

240. Consider the following statements about the suitable utilisation methods for fly ash:
(a) As a replacement for cement in concrete.
(b) In the construction of road embankments.
(c) As a filler in the plastics industry.
(d) As a soil amender for certain types of soil.
(e) As a primary food source for livestock.
Which of the above are correct?
(A) (a), (b), (c), and (d) only
(B) (b), (c), (d), and (e) only
(C) (a), (c), and (e) only
(D) (a), (b), and (e) only

241. A high C:N ratio in organic waste intended for composting will result in:
(A) A very rapid composting process.
(B) A slow composting process due to nitrogen deficiency for microorganisms.
(C) The release of large amounts of ammonia.
(D) The production of a highly acidic compost.

242. In hazardous waste management, oxidation-reduction (redox) reactions are used to:
(A) Convert toxic substances to less toxic forms by changing their chemical state (e.g., Cr6+ to Cr3+).
(B) Change the physical state of the waste from liquid to solid.
(C) Adjust the pH of the waste to 7.0.

201. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Improper management of plastic waste poses a significant threat to marine ecosystems.

Reason (R) : Plastics are readily biodegradable in seawater, releasing nutrients that cause eutrophication.

In light of the above statements, choose the most appropriate answer from the options given below:

(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct but (R) is NOT the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

202. The generation rate of solid waste is most commonly expressed in:

(A) Kilograms per capita per day
(B) Tons per hour
(C) Cubic meters per city
(D) Liters per household

203. Which is the most suitable method for the disposal of biomedical waste such as human anatomical waste and sharps?

(A) Composting
(B) Dumping in municipal bins
(C) Recycling into new medical products
(D) Incineration or autoclaving followed by secure land filling

204. The main components of landfill gas are:

(A) Oxygen and Nitrogen
(B) Methane and Carbon Dioxide
(C) Hydrogen and Helium
(D) Sulphur Dioxide and Ammonia

205. Consider the following actions related to plastic waste management:

(a) Promoting single-use plastics to boost the economy.
(b) Implementing Extended Producer Responsibility (EPR).
(c) Encouraging source segregation of plastic waste.
(d) Developing infrastructure for recycling and co-processing.
(e) Disposing of all plastics directly into landfills without segregation.

Which of the above statement(s) is/are correct?

(A) (a), (b), and (c) only
(B) (b), (c), and (d) only
(C) (c), (d), and (e) only
(D) (a), (d), and (e) only

206. A solid waste sample has high moisture content and high organic content. Which of the following would be the most appropriate treatment method?

(A) Incineration without pre-treatment
(B) Direct land filling without gas collection
(C) Solidification
(D) Composting or biomethanation

207. What is the role of a 'transfer station' in an integrated solid waste management system?

(A) A point of consolidation to reduce transport costs to distant disposal sites.
(B) A place to burn waste in the open.
(C) A final disposal site for hazardous materials.
(D) A community park built on a closed landfill.

208. Which component is determined in an ultimate analysis but not in a proximate analysis of solid waste?

(A) Moisture
(B) Nitrogen
(C) Ash
(D) Volatile Matter

209. The primary reason for the failure of composting as a viable option for mixed municipal solid waste in many cities is:

(A) The high quality and purity of the organic waste stream.
(B) Contamination of the final product with non-biodegradable items like plastics and glass.
(C) The lack of microorganisms in the waste.
(D) The process is too quick to be manageable.

210. Match the e-waste components in List I with the categories in List II.

List I: (E-waste Component)

P. Circuit boards
Q. Plastic casings
R. Copper wires
S. Lead in solder

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251. According to the passage, which factor is NOT mentioned as influencing solid waste generation rates?
(A) Geographic location
(B) Legislative policies
(C) Economic status
(D) Seasonal variations

252. What is the primary purpose of understanding solid waste components like paper, plastics, and glass?
(A) To evaluate its potential for recovery and recycling
(B) To determine the total weight of the waste collected daily
(C) To calculate the required landfill space directly
(D) To decide the type of collection vehicles needed

253. The passage suggests that proximate analysis is particularly crucial for which of the following?
(A) Determining the elemental composition of the waste
(B) Identifying the original sources of the waste
(C) Evaluating the suitability for combustion and biological treatment
(D) Planning collection routes and schedules

254. Which of the following can be inferred as the most fundamental step in creating a solid waste management plan?
(A) Selecting the final disposal technology
(B) Procuring transportation vehicles and containers
(C) Implementing recycling programs immediately
(D) Characterizing the waste stream and its generation

255. As described in the passage, ultimate analysis of solid wastes is concerned with:
(A) Its final destination in a landfill or incinerator.
(B) Its moisture content, volatile matter, and fixed carbon.
(C) Its elemental composition.
(D) Its potential for direct reuse without processing.

Direction : Please read the following source carefully.

The analysis of solid waste is a critical step in determining its potential for energy recovery and selecting appropriate treatment technologies. This is accomplished through two principal methods: proximate analysis and ultimate analysis. Proximate analysis is a partitioning of the combustible components of waste into three categories: moisture, volatile matter, and fixed carbon. The non-combustible residue is identified as ash. This analysis is instrumental in assessing the feasibility of thermal conversion processes like incineration or gasification, as a high moisture content would reduce combustion efficiency, while high volatile matter suggests good potential for energy release. In contrast, ultimate analysis delves deeper into the chemical makeup of the waste, determining the mass percentage of key elements such as carbon (C), hydrogen (H), oxygen (O), nitrogen (N), and sulfur (S), along with the ash content. The results of an ultimate analysis are essential for calculating the calorific value of the waste, which is a direct measure of its energy content. Furthermore, it helps in predicting the composition of flue gases, particularly the formation of pollutants like sulfur oxides (SOx) and nitrogen oxides (NOx), thereby informing the design of necessary air pollution control systems. Together, these two analytical techniques provide a comprehensive profile of solid waste, guiding engineers and planners in making informed decisions for sustainable waste management.

Based on the above source, attempt the following five questions.

256. According to the passage, a high moisture content in solid waste, as determined by proximate analysis, would imply which of the following?
(A) Increased combustion efficiency
(B) Reduced combustion efficiency
(C) Higher calorific value
(D) Greater potential for energy release

257. What information is uniquely provided by ultimate analysis that is not available from proximate analysis?
(A) The percentage of ash content in the waste
(B) The proportion of volatile matter and fixed carbon
(C) The amount of moisture present in the

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8. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Thermal conversion processes require detailed knowledge of waste characteristics to ensure efficient energy recovery. Proximate analysis provides essential data on moisture levels, volatile matter, and fixed carbon, which are the primary factors influencing the heating value. Since these parameters directly determine how waste burns and how much heat it produces, performing this analysis is the necessary first step in evaluating whether incineration or pyrolysis is feasible for a specific waste stream.

9. (C) Ultimate analysis
Ultimate analysis provides a comprehensive breakdown of the elemental constituents present in solid waste samples. This laboratory procedure determines the precise percentages of carbon, hydrogen, oxygen, nitrogen, and sulfur within the material. These data points are critical for calculating stoichiometric oxygen requirements and predicting the chemical composition of emissions during combustion. It differs from proximate analysis, which only identifies broader physical categories like moisture and ash content in waste.

10. (A) Waste generation rates are uniform across a city, with no variation between zones.
Waste generation rates are highly variable and are influenced by factors such as economic status, local lifestyle, and seasonal changes. In any urban area, residential zones with different income levels or commercial districts will produce waste at different rates. Expressed typically in kilograms per capita per day, these rates provide a baseline for planning collection services. Suggesting that generation is uniform ignores the complex socio-economic realities that drive consumption patterns.

11. (C) (a), (b) and (c) only
Different activities generate distinct types of solid waste. Construction sites produce inert materials like bricks and concrete, while commercial establishments like restaurants are primary sources of organic food waste. Agricultural operations contribute significant volumes of crop residues and manure. However, industrial processes are highly complex and can produce both hazardous and non-hazardous wastes depending on the manufacturing operations. Therefore, industrial waste is not exclusively non-hazardous, as it often includes toxic chemical byproducts.

12. (B) Incineration
Incineration relies on the combustion of dry materials to release energy and reduce waste volume. High moisture content significantly lowers the net calorific value of the waste because energy must first be consumed to evaporate the water. In tropical regions, where organic waste often contains a high percentage of water, direct incineration becomes economically and technically challenging. Without pre-treatment like drying or segregation, high moisture prevents the self-sustaining combustion required for efficient incinerator operation.

13. (C) The combustible residue left after volatile matter is driven off
During the proximate analysis of solid waste, fixed carbon represents the solid combustible residue that remains after the moisture and volatile matter have been removed. It is distinct from the total carbon content, as it only accounts for the carbon that does not vaporize easily when heated. This parameter is a vital indicator of the energy potential of the waste, particularly for the design and operation of charcoal production or gasification systems.

14. (A) Both Statement I and Statement II are true.
Ultimate analysis is critical for environmental compliance in waste-to-energy facilities. By identifying the exact amounts of sulfur and chlorine in the fuel, engineers can predict the formation of acidic gases like sulfur oxides and hydrogen chloride during combustion. This information is necessary for designing effective air pollution control systems, such as scrubbers and filters. Therefore, elemental data directly dictate the technical specifications required to mitigate harmful atmospheric emissions from waste incinerators.

15. (A) A system where storage containers are picked up, transported to disposal, and returned.
A Hauled Container System is a waste collection method characterized by the movement of the entire storage container to a processing or disposal site. Once at the facility, the container is

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(A) They generate larger volumes of waste compared to commercial sites.
(B) Residential waste is heavier and requires stationary bins.
(C) It is cheaper to leave the container in place than to haul it.
(D) Waste is collected from numerous, relatively small-volume sources.

265. What aspect of collection route design is NOT explicitly mentioned in the passage?
(A) The day of the week for collection
(B) The impact of one-way streets
(C) The location of the containers
(D) The effect of traffic congestion

Direction : Please read the following source carefully.

As urban areas expand and waste generation increases, the direct hauling of waste from collection points to distant disposal sites becomes economically and environmentally unviable. To address this logistical challenge, transfer stations are incorporated into modern solid waste management systems. A transfer station is a centralized facility where waste from smaller, local collection vehicles is unloaded and consolidated into larger, long-haul transport vehicles, such as semi-trailers or railcars. The primary purpose of a transfer station is to reduce overall transportation costs by taking advantage of the economies of scale associated with larger transport vehicles. This consolidation process significantly decreases the number of vehicle trips to the final disposal or processing facility, thereby reducing fuel consumption, traffic congestion, and air pollution. Furthermore, transfer stations provide an opportunity for preliminary waste processing, such as screening and removal of bulky items or recyclables, which can enhance the efficiency of downstream operations. The strategic location and efficient operation of transfer stations are therefore critical components in optimizing the entire waste transportation network, bridging the gap between local collection and regional disposal or recovery facilities. They are an essential element in the journey of solid waste from its source to its final destination.

Based on the above source, attempt the following five questions.

266. What is the principal economic advantage of using a transfer station as described in the passage?
(A) It eliminates the need for waste collection vehicles.
(B) It reduces overall transportation costs through waste consolidation.
(C) It allows for complete recycling of all incoming waste.
(D) It serves as the final disposal site for municipal waste.

267. According to the passage, the use of transfer stations contributes to environmental benefits primarily by:
(A) Generating electricity from the consolidated waste.
(B) Decreasing the number of vehicle trips to the disposal site.
(C) Neutralizing all hazardous components in the waste.
(D) Producing compost for agricultural use on-site.

268. The passage suggests that, in addition to consolidation, what other activity might occur at a transfer station?
(A) Preliminary screening and removal of certain items
(B) Final sanitary land filling of the waste
(C) Incineration of the collected waste
(D) Ultimate analysis of the waste composition

269. Which of the following statements can be inferred from the passage?
(A) Transfer stations are only useful in small towns with low waste generation.
(B) Direct hauling is always more efficient than using a transfer station.
(C) The efficiency of a waste management system can be improved by optimizing transportation logistics.
(D) All waste that enters a transfer station is eventually land filled.

270. The function of a transfer station is best described as:
(A) A final point of waste disposal.
(B) A facility exclusively for recycling and composting.
(C) A sorting center for hazardous waste only.

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(D) An intermediate hub for waste consolidation and transfer.

Direction : Please read the following source carefully.

In the pursuit of a circular economy, solid waste processing and recovery are pivotal stages that transform waste from a liability into a resource. Recycling is a cornerstone of this approach, involving the collection, sorting, and processing of materials like paper, glass, metal, and plastics to manufacture new products. Beyond conventional recycling, there is a focus on the recovery of materials for direct use in manufacturing. This involves reclaiming specific components from the waste stream that can be integrated into production processes with minimal reprocessing. An example is the direct manufacture of solid waste products, where processed waste itself becomes the raw material for items such as building materials or low-grade furniture. This not only diverts significant volumes of waste from landfills but also reduces the demand for virgin raw materials, conserving natural resources and energy. The success of these recovery operations depends heavily on the purity of the sorted materials and the economic viability of the reclamation and manufacturing processes. Consequently, effective waste processing involves not just the technology for reprocessing but also robust systems for source separation and collection to ensure a clean, high-quality stream of recoverable materials, thereby closing the loop in material life cycles.

Based on the above source, attempt the following five questions.

271. What is the primary goal of solid waste processing and recovery as described in the passage?
(A) To minimize the cost of waste transportation
(B) To accurately measure the volume of landfill waste
(C) To transform waste into a usable resource
(D) To solely focus on reducing waste at the source

272. The passage distinguishes between recycling and direct manufacture of solid waste products by highlighting that the latter:
(A) Is applicable only to organic waste.
(B) Uses processed waste itself as a primary raw material.
(C) Requires more energy than using virgin materials.
(D) Is a less important part of the circular economy.

273. According to the text, what is a crucial factor for the success of material recovery operations?
(A) The distance to the nearest landfill
(B) The total volume of waste generated
(C) The availability of a large labor force
(D) The purity of the sorted materials

274. The passage implies that a significant environmental benefit of recycling and material recovery is:
(A) The reduction in demand for virgin raw materials.
(B) The complete elimination of waste generation.
(C) The increase in landfill operational lifespan.
(D) The simplification of waste collection systems.

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275. The concept of closing the loop mentioned in the passage refers to:
(A) Optimizing waste collection routes to return to the starting point.
(B) Ensuring all waste ends up in a properly sealed landfill.
(C) Reintegrating recovered materials back into the production cycle.
(D) Completing the daily waste management tasks on schedule.

Direction : Please read the following source carefully.

The conversion of solid waste into energy represents a significant strategy for both waste management and sustainable power production. One prominent method is the generation of electrical energy from solid waste through thermochemical pathways. This process often involves the creation of intermediate fuel products from the combustible fraction of municipal solid waste. Fuel pellets are one such product, created by densifying and drying processed waste to produce a uniform, easy-to-handle fuel with a consistent energy content. A more refined product is Refuse Derived Fuel (RDF). The production of RDF involves more extensive processing, including sorting, shredding,

and separation of non-combustible materials, to yield a high-quality fuel with a higher calorific value and lower ash content compared to raw waste. Both fuel pellets and RDF can be co-fired in existing power plants or used in dedicated waste-to-energy facilities to generate electricity. This approach not only diverts substantial amounts of waste from landfills but also recovers the intrinsic energy value of the material. By converting a liability into an asset, the generation of electrical energy from solid waste serves the dual purpose of reducing the environmental burden of disposal and contributing to the energy supply.

Based on the above source, attempt the following five questions.

276. What is the primary purpose of converting solid waste into fuel pellets or RDF?
(A) To create a uniform, energy-rich fuel for electricity generation
(B) To facilitate easier composting and biomethanation
(C) To separate hazardous materials for special disposal
(D) To reduce the moisture content for better land filling

277. According to the passage, how does Refuse Derived Fuel (RDF) differ from fuel pellets or raw waste?
(A) RDF is a liquid fuel, while pellets are solid.
(B) RDF has a lower calorific value and higher ash content.
(C) RDF can only be produced from organic waste.
(D) RDF involves more extensive processing to achieve higher quality.

278. The passage highlights a dual benefit of generating electrical energy from solid waste. What are these two benefits?
(A) Reducing waste collection costs and increasing recycling rates
(B) Diverting waste from landfills and recovering its energy value
(C) Improving air quality and creating jobs in the energy sector
(D) Producing clean water and generating biogas

279. What can be inferred about the raw material for fuel pellets and RDF?
(A) It includes the entire stream of municipal solid waste.
(B) It is primarily composed of the non-combustible fraction of waste.
(C) It consists of the combustible fraction of processed waste.
(D) It is limited to industrial and hazardous waste.

280. The term co-fired, as used in the context of the passage, most likely means:
(A) Burning RDF and fuel pellets together in a dedicated facility.
(B) The simultaneous incineration of waste and land filling of ash.
(C) The process of setting fire to waste within a landfill.
(D) Burning waste-derived fuels alongside conventional fuels in a power plant.

Direction : Please read the following source carefully.

Biological treatment methods offer a sustainable pathway for managing the organic fraction of municipal solid waste by harnessing natural decomposition processes. Composting is an aerobic process where microorganisms break down organic matter in the presence of oxygen, resulting in a stable, humus-like product called compost, which serves as a valuable soil conditioner. A variation of this is vermicomposting, which utilizes specific species of earthworms to accelerate the conversion of organic waste into a high-quality fertilizer known as vermicast. This process is particularly effective for smaller-scale operations and yields a product rich in nutrients. Another significant biological method is biomethanation, also known as anaerobic digestion. This process occurs in the absence of oxygen, where anaerobic bacteria decompose the organic substrate to produce a mixture of gases, primarily methane and carbon dioxide, collectively known as biogas. This biogas can be captured and used as a fuel for heating or electricity generation. The solid residue, or digestate, from the process can also be used as a soil amendment. By converting organic waste into valuable products like compost and renewable energy, these biological treatment methods play a crucial role in diverting waste

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waste sample
(D) The mass percentage of elements like carbon and sulfur

258. The passage suggests that knowledge of the nitrogen and sulfur content from an ultimate analysis is primarily important for what reason?
(A) To predict the formation of air pollutants during combustion
(B) To calculate the total energy content of the waste
(C) To determine the amount of fixed carbon
(D) To assess the biological stability of the waste

259. Which statement best describes the relationship between proximate and ultimate analyses as presented in the text?
(A) They are mutually exclusive methods, and only one is needed.
(B) Proximate analysis is a simpler version of ultimate analysis.
(C) They provide complementary information for evaluating waste treatment options.
(D) Ultimate analysis is used for biological treatment, while proximate analysis is for thermal treatment.

260. A waste manager wishes to calculate the precise calorific value of a solid waste sample to assess its suitability for a waste-to-energy plant. According to the passage, which analysis would be essential for this task?
(A) Ultimate analysis
(B) Proximate analysis
(C) Component analysis
(D) Generation rate analysis

Direction : Please read the following source carefully.

The initial phase of municipal solid waste management, collection, is a logistically intensive and costly operation. The efficiency of this phase is heavily dependent on the container systems employed, which are broadly classified into hauled container systems (HCS) and stationary container systems (SCS). In a hauled container system, the container used for waste storage is itself transported to a processing facility or disposal site, emptied, and then returned to its original location or a new one. This method is typically used for sources generating large volumes of waste, such as commercial establishments or construction sites, where large roll-off containers are common. Conversely, a stationary container system involves collection vehicles that visit fixed container locations, empty the waste into the vehicle, and leave the container in place. This is the more common method for residential areas, utilizing smaller bins or carts that are emptied on a regular schedule. The design of an effective collection strategy also involves the careful layout of collection routes. Optimizing these routes is crucial for minimizing fuel consumption, labor costs, and collection time. Factors such as one-way streets, traffic congestion, and the location of containers must be considered to create a route that is both efficient and safe for collection crews and the public.

Based on the above source, attempt the following five questions.

261. Which of the following scenarios would be most suitable for a hauled container system?
(A) A street with single-family residential homes
(B) A university campus with small, scattered waste bins
(C) A historic city center with narrow alleyways
(D) A large construction and demolition project

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262. What is the key difference between a hauled container system and a stationary container system?
(A) The type of waste collected
(B) The movement of the storage container during collection
(C) The frequency of waste collection
(D) The size of the collection vehicle

263. According to the passage, the layout of collection routes is optimized primarily to:
(A) Ensure all waste is collected regardless of cost.
(B) Comply with local traffic regulations exclusively.
(C) Reduce operational costs, fuel use, and time.
(D) Provide employment for a larger number of collection crews.

264. The passage implies that stationary container systems are preferred for residential areas because:

(D) Enhance the percolation of water to form leachate.

288. According to the passage, a major advantage of incineration is:
(A) Its low operational cost and simplicity.
(B) The significant reduction in waste volume.
(C) The complete elimination of any residual material.
(D) The absence of any air pollution concerns.

289. The passage identifies leachate as a primary concern in landfill management. What is leachate?
(A) A gas produced by waste decomposition, primarily methane.
(B) The soil used to cover waste at the end of each day.
(C) The non-combustible ash residue from incineration.
(D) A contaminated liquid formed by water percolating through waste.

290. What is a significant management challenge associated with incineration mentioned in the text?
(A) The need to manage air emissions and dispose of ash residue.
(B) The slow rate of waste processing.
(C) The large land area required compared to landfills.
(D) The difficulty in compacting the waste before burning.

Direction : Please read the following source carefully.

Hazardous waste poses a significant threat to public health and the environment due to its inherent characteristics, which include ignitability, corrosivity, reactivity, and toxicity. The management of such waste is a specialized field requiring a multi-step approach to neutralize its harmful properties before final disposal. Various treatment methods are employed based on the waste's specific nature. Neutralization is used for acidic or alkaline wastes to adjust their pH to a safer level. Oxidation-reduction (redox) reactions are chemical processes used to convert toxic substances into less harmful ones; for instance, reducing toxic hexavalent chromium to the less toxic trivalent form. Precipitation is a technique used to remove dissolved heavy metals from liquid waste by converting them into an insoluble solid form. For wastes that cannot be easily detoxified, solidification and stabilization methods are used. These processes immobilize the hazardous components within a solid matrix, such as cement or pozzolana, reducing the leachability of contaminants. For certain organic hazardous wastes, high-temperature incineration can be an effective destruction method, although it requires stringent control of emissions. The ultimate goal of these treatment methods is to render the waste non-hazardous or significantly less hazardous, allowing for its safe final disposal.

Based on the above source, attempt the following five questions.

291. A liquid waste with a very low pH is brought to a treatment facility. According to the passage, which treatment method would be most appropriate as an initial step?
(A) Incineration
(B) Precipitation
(C) Neutralization
(D) Solidification

292. What is the primary objective of solidification and stabilization processes in hazardous waste management?
(A) To immobilize hazardous components and reduce their leachability
(B) To completely destroy the hazardous organic compounds
(C) To recover valuable metals from the waste stream
(D) To adjust the pH of the waste to a neutral level

293. The passage mentions the conversion of hexavalent chromium to its trivalent form as an example of which process?
(A) Precipitation
(B) Stabilization
(C) Neutralization
(D) Oxidation-reduction

294. Which characteristic is NOT listed in the passage as a defining feature of hazardous waste?
(A) Corrosivity
(B) Radioactivity
(C) Toxicity

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(D) Ignitability

295. The passage suggests that high-temperature incineration is a suitable treatment for:
(A) All types of hazardous waste without exception.
(B) Immobilizing heavy metals in a solid matrix.
(C) Certain organic hazardous wastes, with strict emission controls.
(D) Liquid wastes that need pH adjustment.

Direction : Please read the following source carefully.

The management of special waste streams, such as e-waste, fly ash, and plastic waste, presents unique challenges due to their specific compositions and environmental impacts. E-waste, or electronic waste, encompasses discarded electrical and electronic equipment and is classified based on its components, which often include valuable metals alongside hazardous substances. Proper handling is crucial to recover resources and prevent the release of toxins, with disposal methods ranging from specialized recycling to secure landfilling. Fly ash, a byproduct primarily from coal combustion in thermal power plants, is a fine particulate material. Its composition includes silica, alumina, and various oxides, and its utilization is encouraged in applications like cement and concrete manufacturing, brick making, and soil stabilization, turning a waste product into a resource. Plastic waste, originating from a vast array of consumer and industrial sources, is a major environmental concern due to its persistence and potential to break down into micro plastics. The consequences include harm to wildlife and ecosystems. Management of plastic waste involves a hierarchy of strategies, including reduction, reuse, recycling, and, for non-recyclable plastics, energy recovery or final disposal, addressing the challenge of its ubiquity and durability.

Based on the above source, attempt the following five questions.

296. According to the passage, what is the primary source of fly ash?
(A) Electronic waste recycling facilities
(B) Plastic manufacturing plants
(C) Municipal solid waste incinerators
(D) Coal combustion in thermal power plants

297. The management of e-waste is described as complex primarily because it contains:
(A) A mixture of both valuable and hazardous substances.
(B) Only biodegradable organic materials.
(C) Large quantities of fly ash and plastic.
(D) Only materials that are easy to recycle.

298. The passage suggests that a key strategy for managing fly ash is:
(A) Its disposal in deep ocean trenches.
(B) Its utilization in manufacturing and construction.
(C) Its permanent storage in underground mines.
(D) Its incineration at very high temperatures.

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299. What is identified as a major environmental consequence of plastic waste?
(A) The release of high levels of radiation
(B) Its persistence and potential harm to wildlife
(C) Its rapid and complete biodegradation
(D) The generation of large volumes of fly ash

300. Which statement best summarizes the management approach for the three wastes discussed?
(A) Each waste requires a specific management strategy based on its unique properties and impacts.
(B) All three wastes should be managed identically through incineration.
(C) The primary goal for all three is disposal in sanitary landfills.
(D) E-waste and fly ash are useful, but plastic waste has no value.

ANSWERS

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1. (B) Any discarded solid material from human or animal activities that is useless or unwanted.
Solid waste encompasses a broad range of materials resulting from human and animal activities that are discarded as useless or unwanted. Unlike liquid or gaseous emissions, this category specifically focuses on solid substances produced in residential, commercial, and industrial settings. Proper management of these materials is essential for public health and environmental protection, as their accumulation can lead to significant pollution and sanitation challenges globally.

2. (A) Residential, commercial, institutional, and municipal sources
Municipal Solid Waste primarily includes wastes generated within a community from diverse sources like households, business establishments, schools, and various local government activities. This classification excludes specialized waste streams like heavy industrial byproducts, agricultural residues, or hazardous hospital wastes. Effective management of these collected materials requires an integrated approach to collection, transport, and disposal to maintain urban cleanliness and ensure sustainable development within urban environments.

3. (C) Statement I is true but Statement II is false.
Higher economic development typically correlates with increased consumption and higher waste generation rates per capita. Consequently, high-income regions produce more waste than low-income ones. However, waste composition is highly dynamic and changes significantly based on the local economy, lifestyle habits, and seasonal variations. Therefore, while waste generation volumes differ by income level, the physical and chemical makeup of that waste is never constant across different regions.

4. (D) The density (mass per unit volume)
Physical characteristics of solid waste are essential for designing collection and disposal systems. Density represents the mass of waste per unit volume and directly influences the selection of storage containers and the compaction requirements for transport vehicles. While chemical properties like carbon content or calorific value determine energy potential, physical parameters like density and moisture content dictate the operational efficiency of the entire municipal waste management logistics chain.

5. (A) P-3, Q-4, R-1, S-2
Solid waste components are classified by their origin and properties. Garbage includes putrescible organic matter from food handling, while rubbish consists of non-putrescible materials like paper and wood. Ashes remain after burning fuels, and demolition wastes result from building construction activities. Accurate identification of these components is crucial for choosing appropriate treatment methods, such as composting for organic garbage or recycling for combustible and non-combustible rubbish items.

6. (B) The weight capacity of collection trucks will be reached before their volume capacity.
When the density of solid waste increases, the same volume of material becomes significantly heavier. In waste logistics, transportation vehicles have limits for both the total volume they can hold and the maximum weight they can safely carry. High-density waste fills up the weight limit of a truck rapidly, even if the storage space is not completely full. This necessitates adjusting collection schedules and route planning.

7. (D) Hydrogen content
Proximate analysis is a standard procedure used to characterize the physical composition of fuels and solid waste. It specifically measures four key components: moisture, volatile matter, fixed carbon, and ash residue. Elemental constituents such as hydrogen, carbon, nitrogen, and sulfur are instead determined through ultimate analysis. Proximate analysis is vital for assessing the suitability of waste for thermal technologies like incineration by providing data on its combustion behavior.

from landfills, reducing greenhouse gas emissions, and promoting a circular economy.

Based on the above source, attempt the following five questions.

281. What is the key difference between composting and biomethanation as described in the passage?
(A) Composting is an aerobic process, while biomethanation is anaerobic.
(B) Composting uses earthworms, while biomethanation uses bacteria.
(C) Composting produces a gas, while biomethanation produces a solid.
(D) Composting is for large-scale operations, while biomethanation is for small-scale.

282. The primary gaseous product of the biomethanation process is:
(A) A humus-like material called compost.
(B) A gas mixture called biogas, rich in methane.
(C) A high-quality fertilizer called vermicast.
(D) A stable solid residue called digestate.

283. Vermicomposting is presented in the passage as a process that:
(A) Occurs in the complete absence of oxygen.
(B) Employs earthworms to produce a high-quality fertilizer.
(C) Is suitable only for large-scale industrial applications.
(D) Uses microorganisms to produce biogas.

284. According to the passage, the end products of these biological treatments (compost, biogas, digestate) are considered valuable because they:
(A) Can be used as soil conditioners or renewable energy sources.
(B) Can be safely disposed of in any landfill.
(C) Represent the complete elimination of waste.
(D) Are sterile and free from any microorganisms.

285. The passage implies that a major environmental benefit of these biological treatments is:
(A) The reduction of waste transportation costs.
(B) The creation of aesthetically pleasing waste facilities.
(C) The diversion of organic waste from landfills.
(D) The increased efficiency of waste collection.

Direction : Please read the following source carefully.

After efforts to reduce, reuse, and recover materials from the waste stream, the final disposal of residual solid wastes must be managed in an environmentally sound manner. The two primary methods for this ultimate disposal are sanitary land filling and incineration. A sanitary landfill is not a mere dump; it is an engineered facility where waste is isolated from the environment. Proper management involves spreading the waste in thin layers, compacting it, and covering it with soil or other materials at the end of each operational day. This management is crucial to control vectors, fires, odors, and wind-blown litter. Furthermore, modern sanitary landfills require liners to prevent leachate—a contaminated liquid that forms as water percolates through the waste—from polluting groundwater, and they must have systems to collect and manage landfill gas, primarily methane. Incineration, on the other hand, is a controlled high-temperature combustion process that drastically reduces the volume of waste. While it offers the advantage of significant volume reduction and potential energy recovery, it must be carefully managed to control air emissions, such as dioxins and furans. The ash residue from incineration, which can contain concentrated contaminants, also requires proper handling and disposal, often in a specialized landfill.

Based on the above source, attempt the following five questions.

286. What is a key feature that distinguishes a sanitary landfill from a simple dump?
(A) It is designed to encourage waste decomposition by exposure to air.
(B) It is used exclusively for the disposal of organic waste.
(C) It does not require daily covering of the waste.
(D) It is an engineered facility with environmental controls like liners.

287. The primary purpose of daily covering of waste in a sanitary landfill is to:
(A) Accelerate the generation of methane gas for collection.
(B) Increase the overall density of the compacted waste.
(C) Control vectors, fires, odors, and litter.

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emptied and then transported back to its original location or replaced with a different empty unit. This system is particularly effective for managing large volumes of waste generated at single points, such as construction sites, large industrial plants, or commercial centers.

16. (B) Stationary Container System - The container is never moved from the point of collection.
In a Stationary Container System, the storage bins remain at the point of waste generation throughout the collection cycle. A specialized collection vehicle travels to each bin, mechanically empties the contents into the truck's compaction body, and then moves to the next location. This contrasts with hauled systems where the container itself is transported. Stationary systems are generally more efficient for residential routes where many small containers must be serviced in a single trip.

17. (B) d, b, a, c
The operation of a Stationary Container System follows a logical cycle to maximize efficiency. First, the collection vehicle arrives and positions itself at a specific container location. Second, the container is mechanically lifted and emptied into the truck. Third, the vehicle drives to the subsequent collection point to repeat the process. Finally, once the truck reaches its capacity, it travels to a transfer station or disposal site to deposit the total accumulated waste.

18. (A) Minimizing non-collection distance and avoiding left turns where possible
Route optimization in waste management focuses on reducing operational costs and improving safety. Minimizing dead-head distance, which is the travel time without collecting waste, ensures that fuel and labor are used efficiently. Furthermore, avoiding left turns and U-turns reduces the risk of accidents and minimizes delays caused by oncoming traffic. These factors are critical for designing a productive route that covers the service area while minimizing the time the vehicle spends on the road.

19. (C) To separate hazardous waste from municipal solid waste.
Transfer stations act as intermediate hubs where waste from small collection trucks is consolidated into larger vehicles for long-distance haulage. Their main functions include providing a central deposit point and compacting waste to reduce volume and transportation costs. While they improve logistics, their primary purpose is not the specialized segregation of hazardous materials from the mixed stream. Such separation is usually handled at the source or at dedicated facilities rather than at a standard municipal transfer point.

20. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Transfer stations become financially viable when the distance to the final disposal site is large enough to justify the overhead of a secondary facility. The economic advantage lies in the use of large-capacity transport vehicles, which reduces the number of trips and total fuel consumption compared to using small collection trucks for the entire journey. This savings in transport logistics must exceed the operational costs of the transfer station for the system to be profitable.

21. (C) Small Collection Vehicles - Used for transport from transfer station to landfill.
Small collection vehicles are designed for the initial pickup of waste from residential and commercial areas due to their maneuverability. Once these trucks deposit their loads at a transfer station, the waste is consolidated into much larger haul vehicles for the final leg of the journey to the landfill. Using small vehicles for long-distance transport to a landfill is highly inefficient and costly. Therefore, large-capacity trucks are always preferred for transporting waste from transfer hubs.

22. (B) (a), (d), and (e) only
Efficient collection routes are designed to minimize travel time and fuel consumption. Starting the route near the garage reduces initial travel distance, while following one-way street directions ensures legal compliance and safety. Additionally, collecting waste on steep hills while driving downhill is safer and puts less strain on the vehicle's engine and brakes. In contrast, sharp turns and servicing congested areas during peak hours increase delays and operational costs, making the overall collection process less efficient.

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consumers to change their purchasing habits. By minimizing the volume and toxicity of materials entering the waste stream, source reduction decreases the overall burden on collection, treatment, and disposal systems, leading to significant environmental and economic benefits for society.

80. (B) Food scraps and yard trimmings
Plastic waste originates from a wide range of human activities, primarily from packaging materials, discarded consumer products, and various industrial or automotive components. These items are composed of synthetic polymers that do not biodegrade easily. In contrast, food scraps and yard trimmings are organic, biodegradable materials that belong to a different category of waste. While they are a major part of the municipal waste stream, they do not contribute to the problem of plastic pollution and are instead suitable for biological treatment.

81. (B) Carbon dioxide and water vapor
The complete combustion of municipal solid waste, which is primarily composed of carbon, hydrogen, and oxygen, results in the oxidation of these elements. Carbon is converted into carbon dioxide, while hydrogen combines with oxygen to form water vapor. These are the primary gaseous products of an efficient incineration process. While other gases like sulfur dioxide or nitrogen oxides may form from minor waste constituents, the bulk of the emissions from the clean combustion of organic matter consists of CO_2 and H_2O.

82. (B) (b), (d), and (e) only
Final disposal refers to the last stage of waste management where materials that cannot be recovered or recycled are permanently isolated from the environment. Sanitary landfilling for municipal waste and secure landfilling for hazardous waste are the primary methods for final disposal on land. Additionally, the residues from incineration, such as ash that cannot be reused, must also be sent for final disposal. Processes like recycling and composting are considered recovery or treatment methods rather than final disposal options.

83. (C) To gather the contaminated liquid from within the landfill for treatment.
A leachate collection system is a critical environmental protection feature in modern sanitary landfills. It consists of a network of perforated pipes and drainage layers installed above the impermeable liner at the base of the landfill. The system is designed to intercept and collect the contaminated liquid that seeps through the waste mass. By removing this leachate, the system prevents the build-up of hydraulic pressure on the liner and ensures that the toxic liquid can be safely transported to a treatment facility.

84. (D) To chemically bind the hazardous constituents, reducing their leachability.
Stabilization of hazardous waste involves mixing the toxic material with additives like cement, lime, or fly ash to induce chemical changes. The primary goal is to transform the hazardous components into less soluble or less toxic forms that are chemically stable. This process significantly reduces the potential for these substances to leach out into the environment when the waste is eventually placed in a landfill. By binding the contaminants, stabilization ensures that the hazardous constituents remain immobilized, protecting groundwater and soil.

85. (A) P-4, Q-1, R-3, S-2
Waste management involves various products and byproducts associated with different treatment processes. Vermicast is the nutrient-rich end product of vermicomposting, while leachate is a contaminated liquid byproduct of landfills. Refuse Derived Fuel represents a specialized fuel produced for energy recovery from processed waste. Dioxins are highly toxic chemicals that can be formed during the incineration of certain materials if not properly controlled. Understanding these associations is essential for managing the environmental impacts and resource potential of different waste streams.

86. (B) Hazardous or toxic materials
E-waste is categorized by its diverse material composition, which includes valuable, inert, and hazardous substances. Elements like lead, found in solder and CRT glass, mercury in switches and lamps, and cadmium in batteries are classified as hazardous or toxic materials. These substances pose significant risks to human health and the environment if released through

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glass and stones, which hinder efficient energy recovery. Processing this waste into Refuse Derived Fuel involves drying and removing these inert fractions to create a concentrated, high-energy fuel. This pre-treatment step is the most suitable approach for improving fuel quality, as it allows for more stable and efficient combustion in waste-to-energy plants or industrial kilns compared to using raw, untreated waste.

31. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Composting is a highly effective biological treatment method for managing organic waste, such as food scraps and garden trimmings. The process relies on aerobic microorganisms that require oxygen to decompose complex organic matter. This natural degradation results in the creation of a stable, nutrient-rich, humus-like substance that can be used as a soil amendment. Since the explanation correctly identifies the aerobic nature and the resulting stable product, both statements are accurate and logically linked.

32. (B) It can effectively process hazardous and heavy metal-contaminated waste.
Vermicomposting uses specific earthworm species to accelerate the decomposition of organic matter, producing a high-quality fertilizer known as vermicast. While it improves soil structure and is faster than traditional methods, it is not suitable for processing hazardous materials or waste contaminated with heavy metals. Earthworms are sensitive to toxins, and hazardous substances can accumulate in their tissues or the final compost, posing risks to the food chain. Therefore, this method is strictly for non-toxic organic waste.

33. (B) Anaerobic microorganisms digest organic matter, producing biogas (methane and carbon dioxide).
Biomethanation is a biological process that occurs in the absence of oxygen, where anaerobic microorganisms break down biodegradable organic waste. This digestion process results in the production of biogas, which is primarily composed of methane and carbon dioxide. Methane is a valuable energy source that can be captured and used for heating or electricity generation. The solid residue left after digestion, known as digestate, can also serve as a nutrient-rich organic fertilizer for agricultural use.

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34. (C) (a), (b), (c) and (d)
Refuse Derived Fuel is a highly engineered product derived from municipal solid waste through several processing steps. It involves removing non-combustible materials and moisture to concentrate the energy-rich components like paper and plastics. This results in a fuel with a significantly higher calorific value than raw waste. RDF is typically manufactured into specific physical forms, such as pellets or fluff, to facilitate easier handling, transportation, and consistent combustion in various industrial boilers and energy recovery facilities.

35. (C) An optimal carbon-to-nitrogen (C/N) ratio, typically around 25:1 to 30:1.
Efficient aerobic composting depends on maintaining the right balance of nutrients for microbial activity. Microorganisms use carbon as an energy source and nitrogen for building proteins and cell structures. An optimal C/N ratio between 25:1 and 30:1 ensures that decomposition proceeds rapidly without generating foul odors or losing nitrogen as ammonia. Deviations from this range can either slow down the process significantly or lead to nutrient imbalances that compromise the quality of the final compost.

36. (D) Refuse Derived Fuel (RDF)
Fuel pellets are a specific form of Refuse Derived Fuel created by compacting processed municipal solid waste. During production, the waste is shredded, dried, and stripped of non-combustible materials to ensure a high and uniform energy content. The resulting pellets are easy to handle and transport, making them an ideal substitute for coal or other fossil fuels in industrial applications. Unlike raw waste, these pellets provide a densified and consistent energy source for efficient thermal conversion.

37. (C) It involves the controlled disposal of waste on land with measures to prevent environmental pollution.
Sanitary landfilling is a scientifically designed method for the final disposal of solid waste on land. Unlike open dumping, it involves spreading and compacting the waste into thin layers and covering it daily with soil. The facility is engineered with protective liners and collection systems to manage leachate and gases, thereby preventing the contamination of soil and

assertion correctly identifies incineration as a standard treatment and the reason explains the underlying mechanism of thermal destruction, both statements are accurate and the reason provides a sound explanation for the practice in hazardous waste management.

52. (D) To protect human health and the environment from the potential hazards of the waste.
The over arching goal of hazardous waste management is to minimize the adverse impacts of toxic, reactive, corrosive, or ignitable materials. This involves a comprehensive system of tracking, treating, and disposing of waste in a manner that prevents human exposure and ecological damage. By implementing strict regulations and engineered solutions, management systems aim to prevent the contamination of air, water, and soil. Protecting the biosphere from the inherent dangers of industrial and domestic hazardous by products remains the primary objective of these essential protocols.

53. (C) Discarded electrical and electronic equipment.
E-waste, or electronic waste, refers to a wide variety of discarded electrical and electronic devices that have reached the end of their useful life. This category includes everything from large appliances like refrigerators and washing machines to smaller consumer goods like mobile phones, computers, and televisions. Due to the rapid pace of technological advancement, e-waste is one of the fastest-growing waste streams globally. It requires specialized handling because it contains both valuable materials and various toxic substances that can harm the environment.

54. (C) Statement I is true but Statement II is false.
E-waste is a complex material stream containing precious metals like gold, silver, and copper, alongside hazardous elements such as lead, mercury, and cadmium. While recovering valuable materials is economically beneficial, the presence of toxic substances means that e-waste cannot be safely disposed of in standard municipal landfills. Without specialized treatment, hazardous chemicals can leach into the soil and groundwater, causing significant environmental pollution. Therefore, Statement I is correct about its composition, but Statement II is false regarding its safe disposal.

55. (D) Open burning to extract metals.
Environmentally sound e-waste management prioritizes the safe recovery of resources and the prevention of pollution. Recommended practices include refurbishing devices for reuse, segregating waste at the source, and using state-of-the-art facilities for metal recovery. In contrast, open burning is a highly dangerous and improper method used in informal sectors to extract valuable metals like copper. This process releases extremely toxic fumes, including dioxins and heavy metal vapors, which pose severe health risks to workers and lead to widespread environmental contamination.

56. (A) The combustion of coal in thermal power plants.
Fly ash is a fine, powdery residue generated during the combustion of pulverized coal in thermal power plants. As the coal burns, non-combustible mineral impurities are carried away by the flue gases and captured by electrostatic precipitators or other filtration systems before they can exit the stack. Because it is produced in massive quantities worldwide, fly ash has become a significant focus for waste utilization strategies, particularly as a valuable raw material in the construction and cement manufacturing industries.

57. (B) b, c, d, a
The waste management hierarchy provides a prioritized framework for sustainable waste handling. The most preferred option is prevention, which focuses on reducing waste at the source. This is followed by recycling and composting to recover materials. Energy recovery, such as incineration with heat capture, is the next option for non-recyclable materials. Final disposal, typically through land filling, is the least preferred method and should only be used for the residual waste that cannot be processed or recovered by any other means.

58. (A) Silica, alumina, and iron oxides
The chemical composition of fly ash is primarily made up of various mineral oxides derived from the inorganic components of coal. The three dominant constituents are silica, alumina, and iron oxides, which together often account for over 70% of the total mass. These oxides give fly ash its pozzolanic properties, allowing it to react

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prevent these substances from entering the food chain or contaminating air and water supplies.

45. (C) P-4, Q-3, R-2, S-1
Hazardous wastes are classified based on distinct physical and chemical properties. Ignitability refers to liquids with a low flash point, while corrosivity is determined by extreme pH levels, either very acidic or highly alkaline. Reactivity describes substances that are unstable and can react violently or explode. Toxicity identifies materials that can cause serious illness or death. Understanding these characteristics is essential for selecting appropriate safety protocols, storage requirements, and treatment methods to mitigate the risks associated with various types of hazardous industrial and domestic waste.

46. (D) Neutralization
Neutralization is a chemical treatment process used to manage hazardous wastes that are highly acidic or alkaline. By adding a base to an acidic waste, or an acid to an alkaline waste, the pH is adjusted toward a neutral value of 7.0. This process makes the waste safer for further treatment or disposal, as it reduces its corrosive potential and may help in the precipitation of heavy metals. It is a fundamental step in treating industrial wastewater and various liquid chemical wastes.

47. (A) To convert the waste into a less soluble, mobile, or toxic form by binding it within a solid matrix.
Solidification and stabilization are treatment techniques aimed at reducing the environmental risk of hazardous waste before land filling. Stabilization involves chemical reactions that transform toxic constituents into less soluble and less mobile forms. Solidification, meanwhile, physically binds the waste within a solid matrix, such as cement or fly ash, creating a monolithic block. Together, these processes ensure that hazardous substances are effectively trapped, preventing them from leaching out and contaminating the soil or groundwater once placed in a secure disposal facility.

48. (C) (a), (b) and (c) only
Effective hazardous waste management utilizes diverse treatment methods based on the waste's properties. Neutralization is primarily used for corrosives, while incineration uses high temperatures to destroy organic toxins. Precipitation is an essential process for removing dissolved heavy metals from liquid streams by making them insoluble. However, solidification is designed to decrease the mobility of contaminants by trapping them in a solid block, rather than increasing it. Therefore, only the statements regarding neutralization, incineration, and precipitation are correct descriptions of these processes.

49. (B) Oxidation-Reduction
Oxidation-reduction, or redox, reactions are used in hazardous waste treatment to change the chemical state of toxic constituents. During this process, electrons are transferred between chemical species, converting hazardous compounds into less toxic or non-hazardous forms. For example, toxic hexavalent chromium can be reduced to the less harmful trivalent form. This chemical conversion is particularly useful for treating liquid waste streams containing heavy metals or persistent organic pollutants, making them safer for subsequent processing or final disposal in a secure facility.

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50. (A) Secure hazardous waste landfill
After hazardous waste has been treated through processes like stabilization, solidification, or incineration, the remaining residues must be disposed of in a secure hazardous waste landfill. These facilities are engineered with much more stringent standards than municipal landfills, featuring double liners, advanced leachate collection, and continuous environmental monitoring. This specialized containment ensures that any remaining hazardous constituents are permanently isolated from the biosphere, preventing long-term contamination of the surrounding soil and groundwater systems, thereby protecting public health and the environment.

51. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Incineration is a widely adopted treatment for hazardous organic wastes, such as spent solvents and pesticides. High-temperature combustion is capable of breaking the chemical bonds of complex toxic molecules, effectively converting them into simpler, less harmful substances like carbon dioxide and water vapor. Because the

23. (B) To reduce transportation costs by consolidating waste into larger vehicles.
In large metropolitan areas, disposal sites are often located far from the city center to comply with environmental regulations and land use policies. Using small collection trucks to travel these long distances is prohibitively expensive due to high fuel use and labor time. Transfer stations solve this problem by allowing small trucks to unload locally. The waste is then compacted and loaded into large-capacity trailers, significantly reducing the total number of trips required for final disposal.

24. (A) Hauled and stationary systems
The two fundamental methods of containerized waste collection are hauled and stationary systems. In a hauled system, the entire container is transported to a disposal or processing site and then returned or replaced. In a stationary system, the container remains at the generation point and is emptied into a collection vehicle that services many locations. The choice between these systems depends on factors such as waste volume at the source, site accessibility, and the available collection equipment.

25. (B) P-3, Q-4, R-1, S-2
Waste processing techniques serve specific environmental and operational goals. Recycling focuses on transforming waste materials into new usable products, while composting utilizes biological processes to decompose organic matter. Incineration is primarily used for volume reduction and energy recovery through combustion. Land filling represents the final disposal of residual waste on land. Together, these methods form an integrated management system that aims to maximize resource recovery while ensuring the safe and controlled disposal of non-recyclable materials in an engineered facility.

26. (A) The segregation of valuable components like paper, glass, and metals from the mixed waste stream.
Material recovery involves identifying and extracting valuable components from the waste stream that can be processed into new products. This stage primarily focuses on the segregation of dry recyclables such as paper, plastics, glass, and various metals. Effective recovery prevents these resources from being lost in landfills and reduces the demand for virgin raw materials. It is a fundamental part of the circular economy, focusing on resource efficiency and reducing overall environmental impact.

27. (D) Recycling helps conserve natural resources and reduces the volume of waste sent to landfills.
Recycling is a critical component of sustainable waste management as it returns used materials back into the production cycle. By reusing resources like paper, glass, and metals, the need for extracting and processing virgin natural resources is significantly reduced, which usually saves energy and lowers carbon emissions. Additionally, diverting these materials from disposal sites extends the operational life of landfills and minimizes the environmental footprint associated with waste burial and uncontrolled dumping.

28. (C) (a), (b) and (c) only
Many solid waste components can be directly manufactured into useful secondary products. Fly ash from power plants is a common raw material for bricks, while recycled plastic can be processed into durable plastic lumber for construction. Organic waste is biologically transformed into compost, a valuable soil conditioner. However, not all waste components can be used without intensive processing, as contaminants and mixed materials often require specialized separation and treatment before they can be converted into new goods.

29. (C) Statement I is true but Statement II is false.
Refuse Derived Fuel is produced by processing municipal solid waste to remove non-combustible materials and moisture, followed by shredding or pelletizing. This processing significantly increases the calorific value of the material compared to raw waste, making it a much more efficient and uniform fuel for industrial applications. Therefore, Statement I is correct regarding its production, while Statement II is false because the primary goal of creating RDF is to achieve a higher, more consistent heating value.

30. (D) Processing the waste into Refuse Derived Fuel (RDF)
Municipal solid waste often contains high levels of moisture and non-combustible materials like

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with calcium hydroxide to form cementitious compounds. This characteristic makes fly ash a highly desirable and functional additive in the production of high-strength concrete and durable building bricks.

59. (D) Contamination of marine environments and harm to aquatic life.
Improper plastic waste management is a major driver of global environmental degradation, particularly in oceans and coastal regions. Because most plastics are non-biodegradable, they persist for centuries, often breaking down into smaller microplastics. These materials can be ingested by marine animals, causing internal injuries or starvation, and can entangle wildlife, leading to death. Furthermore, plastic debris can transport invasive species and absorb toxic chemicals from the water, introducing them into the aquatic food chain and ultimately impacting human health.

60. (B) As a nutritional supplement for livestock.
Fly ash is widely utilized as a resource in various engineering and agricultural applications. Its pozzolanic properties make it ideal for manufacturing Portland Pozzolana Cement and durable bricks. In agriculture, it can serve as a soil conditioner to improve texture and water retention. It is also used in constructing road embankments due to its stability. However, fly ash is never used as a nutritional supplement for livestock, as it contains heavy metals and lack the essential nutrients required for animal health.

61. (C) Reducing the consumption of single-use plastics and promoting recycling.
Sustainable management of plastic waste requires a long-term strategy that addresses the problem at its source. Reducing the overall consumption of single-use plastics is the most effective way to decrease the volume of waste entering the environment. Promoting high-quality recycling ensures that existing plastic remains within the economic cycle, reducing the need for virgin plastic production. These proactive measures are far superior to disposal methods like landfilling or burning, which do not address the root cause of plastic pollution.

62. (A) (a), (b), (c), and (d) only
Informal e-waste recycling involves hazardous processes that lead to severe health consequences. Workers often inhale toxic fumes from open burning and are exposed to heavy metals like lead and mercury, which cause significant neurological and developmental damage. Contact with corrosive acids used for metal extraction can cause skin diseases, while exposure to carcinogens such as dioxins increases the risk of cancer. These activities are entirely detrimental to health and provide no cardiovascular benefits, making proper regulation and formal recycling systems essential.

63. (A) Bioremediation
Bioremediation is an environmentally friendly technology that uses biological agents, primarily microorganisms like bacteria and fungi, to degrade or neutralize contaminants in hazardous waste. These organisms metabolize toxic substances, converting them into less harmful byproducts like water and carbon dioxide. This process can be used to treat soil or water contaminated with oil, solvents, or certain chemicals. While it is slower than some physical or chemical treatments, bioremediation is often more cost-effective and less intrusive for restoring contaminated environmental sites.

64. (B) To prevent waste from blowing away, control odors, and deter pests.
A daily cover is a layer of soil or alternative material applied to the top of the compacted waste at the end of each operational day in a sanitary landfill. Its primary function is to maintain sanitation by preventing lighter waste materials from being dispersed by wind. It also acts as a barrier to control unpleasant odors and discourages the presence of disease-carrying pests like flies, birds, and rodents. This practice is essential for minimizing the environmental and public health impacts of active disposal sites.

65. (B) P-3, Q-4, R-2, S-1
Specific waste streams are characterized by their primary constituents of concern, which dictate their management protocols. E-waste contains hazardous heavy metals like lead and mercury, while fly ash is primarily composed of mineral oxides like silica and alumina. Plastic waste is dominated by non-biodegradable polymers that persist in the environment. Biomedical waste

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is uniquely dangerous due to the presence of pathogens and sharp instruments. Correctly identifying these key constituents is essential for implementing safe collection, treatment, and disposal strategies for each waste type.

66. (A) The production of methane gas through anaerobic digestion of organic waste.
Biomethanation specifically refers to the biological conversion of organic waste into biogas under anaerobic conditions. This process involves a complex series of microbial actions where bacteria break down biodegradable materials like food scraps and manure in the absence of oxygen. The resulting biogas is rich in methane, which can be harnessed as a renewable energy source for heating or power generation. This technology provides a sustainable solution for treating organic waste while simultaneously recovering valuable energy.

67. (D) Using crushed glass as an aggregate in asphalt (glassphalt).
Direct manufacture from solid waste occurs when discarded materials are utilized as raw ingredients in the production of new goods. A clear example is using crushed recycled glass, known as cullet, as a partial replacement for natural stone aggregates in asphalt mixtures, creating a durable road material called glassphalt. While melting cans or repulping paper are recycling processes, they involve returning materials to their base state first. Using waste directly in a manufacturing process like construction aggregate represents a straightforward resource utilization strategy.

68. (C) (a), (b) and (c) only
Vermicomposting is a specialized aerobic biological process that uses specific earthworm species, such as red wigglers, to decompose organic waste. The worms consume the waste, and their digestive processes, along with microbial activity, transform the material into a nutrient-rich organic fertilizer called vermicast. This method is highly effective for biodegradable materials like food and garden waste. However, it is entirely unsuitable for inorganic wastes, as earthworms cannot digest plastic, glass, or metal, and these materials can harm the worms.

69. (C) It mechanically lifts and empties the container's contents into its own body.
In a Stationary Container System, the collection vehicle is designed to service containers that remain at a fixed location. Upon arriving at a collection point, the truck uses mechanical arms or a hoist to lift the full container and empty the waste into its internal storage compartment, which often includes a compaction mechanism. This system allows a single vehicle to collect waste from many locations efficiently without needing to transport each individual bin to a disposal site, making it ideal for residential routes.

70. (B) aerobic; anaerobic
The fundamental difference between composting and biomethanation lies in the presence or absence of oxygen during the biological decomposition process. Composting is an aerobic process where microorganisms require air to break down organic matter into a stable soil amendment. Conversely, biomethanation is an anaerobic process that occurs in an environment without oxygen, leading to the production of methane-rich biogas. Understanding these distinct biological pathways is essential for selecting the appropriate technology for managing different types of biodegradable organic waste.

71. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Effective solid waste management relies on the careful planning of collection routes to ensure operational efficiency and cost-effectiveness. By optimizing the paths taken by collection vehicles, municipalities can minimize total travel distance and time, which directly leads to lower fuel consumption and reduced maintenance costs. This systematic approach also ensures that all service areas are covered reliably. Since both the assertion and the reason correctly highlight these logistical benefits, they are both accurate and the reason explains the necessity of routing.

72. (A) Sulphur
The presence of sulfur in solid waste is a significant environmental concern during thermal treatment. When waste containing sulfur is incinerated, it reacts with oxygen to form sulfur dioxide, a primary precursor to acid rain. Acid rain can cause widespread damage to forests, aquatic ecosystems, and building materials. Therefore, determining the sulfur content through ultimate analysis is critical for

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designing flue gas desulfurization systems in waste-to-energy plants to ensure that emissions comply with environmental standards and prevent atmospheric pollution.

73. (C) Expired pesticides from a farm
Hazardous wastes are identified by their potential to cause harm due to toxicity, flammability, or chemical reactivity. Expired pesticides are a clear example, as they contain concentrated toxic chemicals designed to kill organisms, which can pose severe risks to human health and local ecosystems if not disposed of correctly. In contrast, common items like office paper, vegetable peels, and sawdust from clean wood are generally non-hazardous and can be managed through standard recycling, composting, or municipal disposal systems.

74. (C) Statement I is true but Statement II is false.
Plastics are primarily derived from synthetic polymers that are highly resistant to natural biodegradation, leading to long-term accumulation in soil and water bodies. This persistence causes significant environmental pollution, confirming Statement I. However, plastic recycling is not a simple or universally economic process. The diversity of plastic types, the presence of additives, and contamination issues make large-scale recycling technically challenging and often less profitable than producing virgin plastic. Therefore, Statement II is false as it oversimplifies the complexity of recycling.

75. (D) Precipitation
Precipitation is a chemical treatment process used to remove dissolved hazardous contaminants, such as heavy metals, from liquid waste streams. By adding specific chemical reagents, the dissolved ions react to form insoluble solid particles that settle out of the solution. This allows the hazardous components to be separated as a solid sludge, which can then be further treated or disposed of securely. It is a vital technique in industrial wastewater treatment to prevent toxic metals from being discharged into the environment.

76. (B) It produces a densified, uniform fuel with a higher calorific value per unit mass than raw waste.
Converting municipal solid waste into fuel pellets involves drying, shredding, and removing non-combustible materials, followed by compaction. This process creates a dense, uniform product that is easier to store and transport than raw, bulky waste. More importantly, the removal of moisture and inert fractions results in a fuel with a significantly higher and more consistent calorific value. These pellets can be used as a reliable energy source in industrial boilers, improving the efficiency and stability of the combustion process.

77. (C) The ash produced from incineration is non-toxic and can be used for any purpose.
While incineration effectively reduces waste volume and can recover energy, it produces residual ash that must be managed carefully. Bottom ash and particularly fly ash often contain concentrated amounts of heavy metals and other toxic substances that were present in the original waste. Therefore, incinerator ash is not universally non-toxic and cannot be used for any purpose without rigorous testing and potential treatment. Proper environmental regulations require this ash to be disposed of in secure landfills or used only in specific, controlled applications.

78. (D) Reactivity with calcium hydroxide in the presence of water to form compounds with cementitious properties.
Pozzolanic activity is a critical property of materials like fly ash that makes them valuable in the construction industry. It describes the ability of fine siliceous or aluminous materials to react chemically with calcium hydroxide, a byproduct of cement hydration, in the presence of moisture. This reaction forms stable compounds with cementitious properties, which enhance the strength, durability, and impermeability of concrete. This characteristic allows fly ash to be used as a high-performance partial replacement for traditional Portland cement.

79. (A) Reduce the amount of waste generated at its source.
Source reduction is the highest priority in the waste management hierarchy, focusing on preventing waste generation before it occurs. This strategy involves designing products with less packaging, increasing the durability of goods to extend their lifespan, and encouraging

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groundwater. This approach ensures that waste is isolated from the environment until it has safely decomposed through biological and chemical processes.

38. (B) Leachate
Leachate is a highly contaminated liquid that forms when water, either from rainfall or the waste itself, percolates through the buried material in a landfill. As it moves, it dissolves various organic and inorganic chemicals and picks up suspended solids and pathogens. If not properly collected and treated, leachate can seep into the ground, posing a severe threat to underlying aquifers and local surface water bodies. Management systems in modern landfills are designed to capture and treat this hazardous by product.

39. (D) To prevent the contamination of underlying soil and groundwater by leachate.
The primary function of a liner system at the base of a sanitary landfill is to create an impermeable barrier between the decomposing waste and the natural environment. This prevents leachate, which contains a high concentration of pollutants, from migrating into the soil and contaminating the groundwater table. Liners are typically constructed from layers of compacted clay, synthetic geomembranes, or a combination of both. This containment strategy is essential for ensuring the long-term environmental safety of disposal sites.

40. (A) Controlled combustion to reduce waste volume and recover energy.
Incineration is a thermal treatment technology that involves the controlled burning of solid waste at high temperatures. The process drastically reduces the volume and mass of the waste, leaving behind a small amount of ash. Modern incinerators are designed to capture the heat generated during combustion to produce steam for electricity or district heating. This dual function of volume reduction and energy recovery makes incineration a popular choice for waste management in regions with limited land availability.

41. (C) The emission of air pollutants like dioxins, furans, and heavy metals.
While incineration effectively reduces waste volume, it poses significant environmental challenges related to air quality. The combustion of mixed materials, especially certain plastics and chemicals, can release highly toxic substances such as dioxins, furans, and volatile heavy metals like mercury. To mitigate these risks, modern incinerators must be equipped with sophisticated air pollution control systems, including scrubbers and high-efficiency filters, to capture harmful pollutants before they are released from the stack into the atmosphere.

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42. (A) (a), (b), (c), and (d) only
A modern sanitary landfill is a complex engineering facility requiring multiple integrated systems for environmental protection. Key components include a bottom liner to contain leachate and a collection system to treat the contaminated liquid. Additionally, gas management systems are necessary to control methane, while daily and final covers prevent odors and pests. Open dumping is an unscientific practice that is strictly prohibited in sanitary landfill design, as it lacks the controls necessary to prevent soil, air, and water pollution.

43. (D) Biodegradability
Hazardous waste is defined by specific properties that pose immediate or long-term threats to human health and the environment. These core characteristics include ignitability, corrosivity, reactivity, and toxicity. Biodegradability, on the other hand, is a property associated with organic wastes that can be broken down naturally by microorganisms, such as food or garden waste. While some hazardous chemicals may eventually degrade, high biodegradability is generally a characteristic of non-hazardous municipal waste rather than the criteria used for hazardous waste classification.

44. (B) A wide range of acute and chronic diseases, including cancers and neurological disorders.
Exposure to hazardous waste can lead to severe health consequences for humans and wildlife. Toxic substances found in these wastes can cause acute reactions, such as chemical burns or poisoning, as well as chronic conditions from long-term exposure. Common health impacts include various types of cancers, respiratory illnesses, and damage to the central nervous system or reproductive organs. Proper handling, treatment, and secure disposal are critical to

improper dismantling or disposal. Their presence necessitates stringent regulations and specialized recycling processes to ensure they are safely managed and prevented from contaminating the biosphere during resource recovery.

87. (D) It enhances soil fertility and water retention capacity.
Plastic waste is known for its persistent negative environmental impacts rather than any benefits to soil quality. It can entangle wildlife, break down into microplastics that enter the food chain, and clog urban drainage systems, which often leads to localized flooding. Suggesting that plastic enhances soil fertility is incorrect; instead, plastic pollution can degrade soil health and interfere with the natural movement of water and nutrients. Proper management is essential to prevent these widespread ecological and infrastructural consequences.

88. (A) (a), (c) and (d) only
Landfill gas is a significant byproduct of waste disposal, primarily composed of methane and carbon dioxide. It is generated through the anaerobic decomposition of organic matter by bacteria in the absence of oxygen. Methane is a potent greenhouse gas that contributes to global warming, but it can also be captured and used as a renewable energy source. Therefore, statements regarding its composition, energy potential, and environmental impact are correct, while the claim that it is produced by aerobic decomposition is false.

89. (C) Corrosive
Corrosivity is a hazardous waste characteristic determined by extreme pH levels. Aqueous wastes with a pH less than or equal to 20 or greater than or equal to 125 are classified as corrosive. A waste sample with a pH of 1.5 is highly acidic and can aggressively attack and dissolve metals or cause severe chemical burns to living tissue. This classification ensures that such materials are handled with specialized safety equipment and treated, often through neutralization, before final disposal.

90. (A) Reduce, Reuse, Recycle, Recover, Dispose
The waste management hierarchy provides a structured approach to sustainability, prioritizing actions that prevent waste over those that manage it. The preferred order starts with reduction at the source, followed by reuse of products and recycling of materials. If materials cannot be recycled, energy or resource recovery is the next option. Final disposal, such as land filling, is the last resort for residues that cannot be managed through any higher-level strategy. This hierarchy aims to maximize resource efficiency and minimize environmental impact.

91. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Secure landfills are specifically designed to contain hazardous wastes that pose high risks to human health and the environment. These facilities require much more stringent engineering standards than municipal landfills, including double liner systems and extensive monitoring networks to prevent any leakage. The reason provided is accurate, as the high toxicity and persistence of hazardous chemicals necessitate these advanced containment measures to protect vital groundwater resources and public safety. Therefore, both statements are correct, and the reason explains the assertion.

92. (B) Biomethanation
Biomethanation is a biological waste treatment technology based on the principle of anaerobic digestion. In this process, microorganisms break down biodegradable organic matter in an environment devoid of oxygen. This leads to the production of biogas, a mixture of methane and carbon dioxide, which can be harnessed as a renewable energy source. While composting is also biological, it is an aerobic process requiring oxygen. Biomethanation is particularly effective for managing wet organic wastes like food scraps, manure, and sewage sludge.

93. (C) Elemental composition (C, H, O, N, S)
Ultimate analysis is a detailed laboratory procedure used to determine the elemental composition of a solid waste sample. It measures the weight percentages of carbon, hydrogen, oxygen, nitrogen, and sulfur. These elemental data points are essential for calculating the theoretical energy content of the waste and for predicting the chemical composition of combustion emissions. This differs from proximate analysis, which focuses on physical components like moisture

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particles that were present in coal. Due to its rapid cooling from high temperatures in power plant boilers, its physical and chemical properties are remarkably similar to those of natural volcanic ash. Both materials are largely composed of spherical, glassy particles and exhibit pozzolanic activity, which allows them to react with lime to form cementitious compounds. This similarity is why fly ash is so effective as a supplementary material in concrete.

108. (A) (a), (b), (c), and (d) only
Improper disposal of plastic waste leads to diverse and severe environmental consequences. Plastics can physically block urban drainage systems, causing flooding, and are frequently ingested by animals, leading to internal injuries. Over time, plastics break down into microplastics that enter the food chain and can release toxic chemical additives like phthalates or flame retardants into the environment. However, plastics are largely non-biodegradable and do not enrich the soil. Therefore, only the statements related to environmental harm and persistence are accurate descriptions of plastic waste impacts.

109. (C) Its main component, methane, is a potent greenhouse gas.
Landfill gas is a major environmental concern because it is primarily composed of methane and carbon dioxide, both of which are significant greenhouse gases. Methane is particularly problematic as its global warming potential is many times higher than that of carbon dioxide over a century-long period. If not captured and managed, the uncontrolled release of landfill gas contributes significantly to climate change. Modern landfills utilize collection systems to mitigate these emissions and often use the captured methane as a source of renewable energy.

110. (D) It is a segregated, high-calorific value fraction of processed MSW, often pelletized.
Refuse Derived Fuel is a specialized fuel produced from the combustible fraction of municipal solid waste. The production process involves shredding the waste, removing non-combustible items like glass and metals, and drying it to reduce moisture content. The resulting material is often compacted into pellets or used as fluff to ensure a high and consistent energy density. RDF is used as a substitute for coal in various industrial applications, providing an efficient way to recover energy from non-recyclable combustible waste components.

111. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
The carbon-to-nitrogen ratio is a fundamental parameter for successful composting because it determines the availability of essential nutrients for the microorganisms involved. Bacteria and fungi use carbon as an energy source for their metabolic activities and nitrogen for synthesizing proteins and building cell structures. An optimal ratio ensures that the decomposition process is efficient and proceeds without the formation of foul-smelling gases like ammonia. Both the assertion and the reason correctly identify this critical biological requirement and its impact on the composting process.

112. (B) Electronic Waste
E-waste is the commonly used abbreviation for electronic waste, which refers to discarded electrical and electronic devices that are no longer wanted or functional. This broad category includes items like computers, smart phones, televisions, and large household appliances. E-waste is distinguished from other waste streams because it contains a complex mixture of valuable materials, such as precious metals, and hazardous substances like lead and mercury. Proper management of e-waste is essential for resource recovery and preventing environmental pollution from its toxic components.

113. (B) The wide variety of polymer types, which often require separation for effective recycling.
One of the most significant challenges in plastic waste management is the extreme diversity of plastic resins used in manufacturing. Different polymers, such as PET, HDPE, and PVC, have distinct chemical properties and melting points, meaning they generally cannot be recycled together into high-quality products. Sorting these materials from a mixed waste stream is labor-intensive and technically difficult. This requirement for precise separation often limits the economic viability and overall efficiency of large-scale plastic recycling programs in many urban waste systems.

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biomethanation, and recycling. By prioritizing these steps, the rules aim to minimize the volume of waste sent to landfills and encourage the circular economy. This approach reduces environmental pollution and promotes the sustainable utilization of discarded materials within the community.

101. (A) b, d, a, c
An effective waste management system follows a logical flow from the point of generation to resource recovery. The process begins with residents segregating their waste into distinct categories like dry and wet. Next, collection vehicles pick up these segregated components and transport the dry waste to a materials recovery facility. At the facility, recyclables are further sorted, baled, and finally sent to specialized industries for recycling. This sequence ensures that materials are handled properly at each stage to maximize the efficiency of recovery.

102. (B) It has a high capital cost and requires skilled operation.
Incineration is a complex thermal technology that requires significant financial investment for the construction of specialized furnaces and advanced air pollution control systems. Furthermore, the operation of an incinerator is technically demanding, necessitating highly skilled personnel to manage combustion conditions and monitor emissions to ensure environmental compliance. These high capital and operational costs are major disadvantages compared to simpler disposal methods like land filling, making incineration less feasible for many smaller municipalities or those with limited technical and financial resources.

103. (D) Putrescible wastes, primarily from food preparation and consumption.
In the context of solid waste management, the term garbage specifically refers to the putrescible fraction of waste. This includes animal and vegetable residues resulting from the handling, preparation, cooking, and consumption of food. Because garbage is highly organic and has a high moisture content, it decomposes rapidly, often producing unpleasant odors and attracting pests. This characteristic makes it the primary candidate for biological treatment methods such as composting or biomethanation, where it can be converted into useful soil amendments or energy.

104. (A) Biomethanation - Requires a constant supply of oxygen.
Biomethanation is a biological process that occurs specifically under anaerobic conditions, meaning it must take place in an environment completely devoid of oxygen. During this process, anaerobic bacteria break down organic matter to produce methane and carbon dioxide. In contrast, composting is an aerobic process that requires oxygen. Proximate and ultimate analyses are correctly matched with their functions of determining physical components and elemental composition, respectively. Therefore, the statement claiming biomethanation requires oxygen is incorrect, as oxygen would actually inhibit the process.

105. (C) P-3, Q-4, R-1, S-2
Hazardous waste treatment utilizes various mechanisms to reduce toxicity or mobility. Neutralization adjusts pH by adding acids or bases, while precipitation converts dissolved substances into insoluble solids for easy removal. Solidification involves encapsulating waste within a stable solid matrix like cement to prevent migration. Oxidation is a chemical process that removes electrons from a substance to transform it into a less harmful form. Understanding these specific mechanisms is essential for selecting the most effective treatment strategy based on the chemical properties of the hazardous waste.

106. (A) A large roll-off or drop-box container that is transported to the disposal site.
A key feature of a Hauled Container System used for commercial or industrial waste is the use of large-capacity containers, such as roll-off bins or drop-boxes. These containers are designed to be picked up in their entirety by a specialized vehicle and transported directly to a processing or disposal facility. Once emptied, the container is either returned to the source or replaced with an empty one. This system is highly efficient for managing large concentrated volumes of waste at a single location.

107. (D) Volcanic ash
Fly ash is a fine-grained material composed primarily of siliceous and aluminous mineral

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and volatile matter to assess the general burning characteristics of the material.

94. (B) It leads to the leaching of heavy metals and other toxic substances into the soil and water.
Disposing of e-waste in uncontrolled open dumps poses a severe environmental threat due to the presence of hazardous materials. Over time, toxic substances like lead, mercury, and flame retardants can be released from electronic components. When rainwater percolates through the waste, these chemicals leach into the soil and can eventually contaminate underlying groundwater aquifers. This leads to long-term environmental degradation and can introduce dangerous toxins into the local food chain, seriously impacting human health and biodiversity in the area.

95. (A) Be dangerously unstable, react violently with water, or generate toxic gases.
Reactivity is a key characteristic used to identify hazardous waste that is chemically unstable under normal conditions. Reactive wastes can explode, undergo violent chemical changes, or react dangerously when mixed with water. They may also release toxic gases, such as hydrogen cyanide or hydrogen sulfide, which are lethal to humans and animals. This property makes these materials extremely dangerous to handle, transport, and store, requiring specialized safety protocols and treatment to neutralize their potential for sudden and harmful chemical reactions.

96. (B) As a partial replacement for cement in concrete
A primary utilization pathway for fly ash is as a supplementary cementitious material in the concrete industry. Due to its fine particle size and pozzolanic properties, fly ash reacts with calcium hydroxide during cement hydration to form stable, strength-enhancing compounds. Using fly ash as a partial replacement for Portland cement not only improves the durability and workability of concrete but also reduces the overall carbon footprint of construction projects. This practice diverts large volumes of waste from landfills into useful structural applications.

97. (D) Statement I is false but Statement II is true.
Vermicomposting is a biological decomposition process that relies on the activity of earthworms and mesophilic microorganisms. Unlike traditional thermophilic composting, which can reach temperatures above 60°C to kill pathogens, vermicomposting must be maintained at mesophilic temperatures, typically between 20°C and 30°C, to ensure the survival and health of the earthworms. High temperatures would be lethal to the worms. Therefore, Statement I is false because the process is not thermophilic, while Statement II correctly identifies its reliance on mesophilic conditions.

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98. (A) Improve the efficiency of waste transportation to distant disposal sites.
Transfer stations serve as intermediate hubs in the solid waste logistics chain. Their primary role is to accept waste from smaller collection vehicles and consolidate it into larger, high-capacity transport trucks or trailers. This consolidation is essential for reducing the total number of trips and overall transportation costs when final disposal sites are located far from the city. While some stations may include material recovery or sorting, their fundamental purpose remains the optimization of waste haulage to ensure economic and operational efficiency.

99. (C) Changing the oxidation state of a substance to convert it into a less toxic form.
Oxidation-reduction treatment for hazardous waste involves chemical reactions that alter the oxidation state of toxic constituents. By transferring electrons, hazardous compounds are transformed into less toxic or more stable forms. For example, toxic cyanide can be oxidized to less harmful cyanate, or hexavalent chromium can be reduced to the safer trivalent state. This chemical transformation is a critical technique for treating industrial effluents and liquid hazardous wastes, making them suitable for further processing or safe disposal in a secure facility.

100. (D) Source segregation and resource recovery
Solid waste management rules in India prioritize a hierarchy that emphasizes the management of waste as a resource. The primary focus is on source segregation, where residents separate waste into biodegradable, non-biodegradable, and hazardous categories. This facilitates efficient resource recovery through composting,

114. (A) Chemically reduce the hazard potential by converting constituents to less soluble or toxic forms.
In the context of hazardous waste management, stabilization is a chemical treatment process that aims to decrease the potential for contaminants to migrate into the environment. It involves adding specific reagents that react with the hazardous components to transform them into less soluble, more stable, or less toxic chemical forms. This process is often followed by solidification, where the waste is physically bound in a solid block. Together, these steps ensure that hazardous substances are immobilized before their final disposal in a secure landfill.

115. (A) (a) and (b) only
Characterizing solid waste involves measuring physical properties like density and moisture content, and chemical properties such as pH and calorific value. These parameters are essential for designing collection and treatment systems. However, proximate analysis determines moisture, ash, volatile matter, and fixed carbon, rather than elemental carbon, hydrogen, and oxygen, which are part of an ultimate analysis. Furthermore, waste composition is highly dependent on lifestyle and economic conditions. Therefore, only the statements defining physical and chemical characteristics are correct in this context.

116. (D) Reduction
Reduction is a chemical process used in hazardous waste treatment to decrease the toxicity of certain metallic contaminants by changing their oxidation state. A classic example is the conversion of hexavalent chromium, which is highly toxic and mobile, into the trivalent form, which is significantly less toxic and more stable. This transformation involves the addition of electrons to the chromium ions. This technique is a standard industrial practice for treating wastewater from metal plating and other manufacturing processes before the effluent can be safely discharged.

117. (C) An engineered facility for disposing of solid waste on land in a manner that protects the environment.
A sanitary landfill is a sophisticated engineering project designed for the permanent disposal of solid waste on land. Unlike uncontrolled dumps, it features protective measures such as impermeable bottom liners to prevent groundwater contamination and systems to collect and treat leachate and gases. Waste is spread in thin layers, compacted, and covered daily with soil to control odors and pests. This systematic approach ensures that the waste is isolated and decomposes safely, minimizing its impact on public health and the surrounding ecosystem.

118. (B) Biomethanation plants
Fly ash is a particulate residue formed during high-temperature combustion processes where non-combustible mineral impurities in fuels are vaporized and then cooled. Common sources include coal-fired power stations, municipal solid waste incinerators, and certain industrial furnaces. In contrast, biomethanation is a biological process that occurs at low temperatures through the action of microorganisms in the absence of oxygen. Because it does not involve combustion, biomethanation plants do not generate fly ash. Instead, they produce biogas and a solid or liquid residue called digestate.

119. (D) Collection and transportation
The layout of collection routes is a vital logistical component within the functional element of collection and transportation in solid waste management. It involves designing the most efficient paths for vehicles to travel from the storage points to the disposal or transfer sites. Proper routing aims to minimize fuel consumption, labor costs, and the time spent on non-collection activities. This planning ensures that all waste is picked up reliably while maximizing the operational efficiency of the municipal fleet and reducing the overall environmental footprint.

120. (A) Exposure to asbestos can lead to lung diseases.
Hazardous wastes can have severe and specific impacts on human health depending on the type of material and the route of exposure. Asbestos is a well-known hazardous material that, when its fibers are inhaled, can cause serious lung conditions, including asbestosis and mesothelioma. This illustrates the direct link between hazardous waste exposure and chronic illness. While other wastes like organic matter or

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Solidification is a physical treatment method for hazardous waste that aims to change its physical state and reduce its potential for migration into the environment. This involves mixing the waste with a binding agent, such as cement, asphalt, or fly ash, to create a solid, stable block or matrix. This process physically traps the hazardous constituents, making them easier to handle and reducing the surface area available for leaching. Unlike incineration or neutralization, which involve chemical or thermal changes, solidification primarily relies on physical binding to stabilize the waste.

135. (C) (a), (b) and (d) only
Fly ash is a versatile material widely utilized in engineering and construction applications. It is a key ingredient in cement manufacturing and the production of durable bricks and blocks. Additionally, its physical properties make it suitable as a soil stabilizer for road embankments. While it can be used in agriculture as a soil conditioner, it is never used in animal feed because it contains heavy metals and lacks nutritional value. Therefore, the statements regarding its use in cement, roads, and bricks are correct, highlighting its importance in sustainable resource utilization.

136. (A) Dioxins and furans
The open or uncontrolled burning of certain plastic wastes, particularly polyvinyl chloride, is extremely dangerous due to the release of highly toxic chemicals. PVC contains chlorine, which, during low-temperature combustion, can react with organic matter to form dioxins and furans. These substances are persistent organic pollutants that are carcinogenic and can cause severe reproductive and developmental problems. This health risk underscores the importance of proper waste segregation and the use of high-temperature incineration with advanced air pollution control systems for the safe disposal of chlorine-containing plastic wastes.

137. (C) Glass and ceramics
The density of different solid waste components varies significantly based on their material properties and state of compaction. Among common municipal waste materials, glass and ceramics have the highest density in their typical loose state. This is because they are made of dense, non-porous mineral substances that occupy little volume for a given mass. Understanding these variations in density is crucial for designing efficient collection and transport systems, as dense materials rapidly reach the weight limits of vehicles, while light materials like plastics and paper occupy more space.

138. (A) Render the waste non-hazardous or less hazardous by chemical reactions.
The primary objective of stabilization in hazardous waste management is to use chemical reactions to transform toxic constituents into more stable, less mobile, or less toxic forms. This process involves adding reagents that chemically bind with the hazardous elements, significantly reducing their potential to leach into the environment. While it may also reduce the solubility of contaminants, its main focus is the chemical conversion of the waste to a safer state. This ensures that the waste poses a much lower risk to public health and groundwater when disposed of.

139. (A) Both Statement I and Statement II are true.
In the planning of solid waste collection routes, designing paths in loops is a highly recommended practice to maximize operational efficiency. Looped routes allow the collection vehicle to cover a specific area comprehensively and return toward its starting direction without unnecessary backtracking. This minimize the non-collection distance, often called dead-head time, where the truck is moving but not picking up waste. Since Statement I suggests the use of loops and Statement II explains the logistical benefit of minimizing dead-head distance, both statements are accurate.

140. (B) High nutrient value for agriculture
Hazardous wastes are identified by specific properties that pose significant risks to health and the environment, such as corrosivity, ignitability, reactivity, and toxicity. These characteristics necessitate specialized and expensive management protocols. In contrast, having a high nutrient value is a characteristic of non-hazardous organic wastes like food scraps or manure, which are beneficial for agricultural use through composting. Therefore, high nutrient value is not a property associated with hazardous waste classification and is instead a positive

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are essential for evaluating the waste's suitability for thermal treatment processes like incineration. For example, high volatile matter indicates easier ignition, while high moisture content lowers the energy potential. This analysis provides a baseline for understanding the combustion behavior of different waste materials.

128. (A) (a), (b), (c), and (d) only
A comprehensive e-waste management system requires multiple integrated components to ensure resource recovery and environmental protection. This includes efficient collection mechanisms like take-back schemes, formal facilities for safe dismantling, and a clear policy framework such as Extended Producer Responsibility. Public awareness is also critical to ensure participation. However, open burning is an extremely hazardous and prohibited practice that releases toxic pollutants. Therefore, an effective management system excludes such harmful activities and instead focuses on regulated, environmentally sound practices that minimize risks to human health and the environment.

129. (B) To prevent the uncontrolled release of methane and other gases, and potentially use it for energy.
Landfill gas is a major by product of the anaerobic decomposition of organic waste, primarily consisting of methane and carbon dioxide. A gas collection system is essential to prevent these gases from migrating through the soil or being released into the atmosphere, where they contribute to global warming and create explosion hazards. Captured gas can be flared to reduce its impact or, more ideally, processed and used as a renewable fuel for generating electricity or heat, providing both environmental and economic benefits.

130. (A) Oxidation
Oxidation is a chemical treatment process used to reduce the toxicity of hazardous wastes by changing the chemical structure of contaminants. In the case of cyanide-containing waste, an oxidizing agent is used to convert the highly toxic cyanide ion into the significantly less harmful cyanate ion. This process involves the loss of electrons from the cyanide species. It is a critical safety procedure in industries like metal plating and mining to ensure that toxic effluents are properly treated before they are safely discharged or disposed of.

131. (C) Dry paper and plastics with high calorific value.
The efficiency of a waste-to-energy incineration plant depends heavily on the energy content of the fuel it processes. Materials like dry paper and various plastics are highly desirable because they have high calorific values and low moisture content, allowing for stable and high-temperature combustion. This results in greater energy recovery in the form of steam or electricity. In contrast, wet organic waste or non-combustible materials like glass and demolition debris provide little to no energy and can actually hinder the incinerator's performance by lowering the overall furnace temperature.

132. (D) Vermicomposting
Vermicomposting is a biological process that uses specific species of earthworms to break down and stabilize organic solid waste. The worms consume the waste, and through their digestive system and the activity of associated microorganisms, the material is transformed into a nutrient-rich, humus-like organic fertilizer called vermicast. This method is often faster than traditional composting and produces a high-quality product that improves soil aeration and fertility. It is a sustainable and effective solution for managing biodegradable wastes like food scraps and garden trimmings in a decentralized manner.

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133. (C) The high content of inert materials and plastics in unsorted waste.
The primary challenge for composting facilities in many developing countries is the poor quality of the input material. When municipal solid waste is not segregated at the source, it contains a high percentage of non-biodegradable and inert materials such as plastics, glass, and stones. These contaminants interfere with the biological process, damage equipment, and result in a final compost product of very low quality and market value. Without effective source segregation, it is difficult to maintain the biological efficiency and economic viability of large-scale composting operations.

134. (D) Solidification

fly ash pose different risks, they do not generally improve health, and the health effects of asbestos are a definitive example of toxicity.

121. (C) Improve its homogeneity and increase its density.
Shredding is a physical processing step in waste management where solid waste is mechanically cut into smaller, more uniform pieces. This process improves the homogeneity of the waste stream, making it easier to handle and process in various facilities. Furthermore, shredding increases the bulk density of the waste, which allows for better compaction in landfills or transport vehicles. This volume reduction leads to more efficient use of landfill space and reduces transportation costs by allowing more waste to be carried in a single trip.

122. (A) Secure landfills have more stringent containment features like double liners and enhanced monitoring systems.
Secure landfills are specifically engineered for the disposal of hazardous wastes that pose a significant long-term threat to the environment and public health. They feature much more rigorous design standards than sanitary landfills, including double liner systems, advanced leachate collection, and more comprehensive monitoring of groundwater and air quality. These enhanced containment features are necessary to prevent any potential leakage of toxic chemicals. In contrast, sanitary landfills are designed for the controlled disposal of relatively less hazardous municipal solid waste.

123. (A) Both Statement I and Statement II are true.
The carbon-to-nitrogen ratio is critical for the biological efficiency of composting. If the initial C/N ratio is too low, such as 10:1, there is an excess of nitrogen that microorganisms cannot utilize, leading to its loss as ammonia gas and resulting in foul odors. Conversely, a very high ratio, like 100:1, means there is insufficient nitrogen to support the growth and activity of the microbial population, which significantly slows down the decomposition process. Therefore, both statements correctly describe the negative impacts of improper nutrient balance.

124. (B) Prevention and Reuse
The e-waste management hierarchy follows the same sustainability principles as general waste, prioritizing actions that avoid waste generation. Prevention and reuse are the most preferred options because they extend the life of electronic devices and reduce the demand for new resources and the energy needed for manufacturing. By keeping products in use longer through repair or refurbishment, the overall environmental footprint of electronics is significantly minimized. These strategies are far superior to recycling or disposal, which involve more energy-intensive processes and higher environmental risks.

125. (C) P-4, Q-3, R-1, S-2
Different waste treatment processes are characterized by their primary agents or environmental conditions. Vermicomposting relies on the action of earthworms, while biomethanation uses anaerobic microorganisms to produce energy. Incineration is a thermal process requiring high temperatures and the presence of oxygen for combustion. Neutralization is a chemical technique that utilizes acids or alkalis to adjust the pH of hazardous waste. Understanding these fundamental requirements is essential for designing and operating effective waste processing facilities to manage diverse organic and inorganic waste streams.

126. (D) A Stationary Container System (SCS)
A Stationary Container System is a waste collection method where storage bins remain at the point of waste generation throughout the collection cycle. A specialized collection vehicle travels to each bin, mechanically empties its contents into the truck's storage body, and then moves to the next location. This system is highly efficient for residential and small commercial routes because it allows a single vehicle to service many locations in one trip, minimizing the time spent transporting individual containers to a disposal site.

127. (A) The percentages of moisture, volatile matter, fixed carbon, and ash.
Proximate analysis is a standard laboratory procedure used to determine the physical and chemical characteristics of solid waste and fuels. It involves measuring four key components: moisture content, volatile matter, fixed carbon, and the remaining ash residue. These parameters

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attribute for resource recovery from organic municipal and agricultural waste streams.

141. (C) (A) is correct but (R) is not correct.
Sanitary land filling is a common method for waste disposal globally, particularly in developing countries, because it is generally more cost-effective and technically simpler than advanced options like high-temperature incineration with energy recovery. While it is an engineered facility, it does not have the highest operational cost; in fact, its relative affordability is a primary reason for its widespread use. Therefore, while the assertion correctly identifies the prevalence of the method, the reason given is incorrect as it misrepresents the relative complexity and cost of the technology.

142. (D) Incineration
Incineration is a thermal treatment technology that utilizes high temperatures and the presence of oxygen to achieve the controlled combustion of solid waste. This process is designed to destroy the organic fraction of the waste, converting it into carbon dioxide, water vapor, and ash. By significantly reducing the volume and mass of the waste, incineration helps extend the life of landfills. Modern incinerators are also equipped to recover energy in the form of heat or electricity, making them an important part of integrated waste-to-energy systems.

143. (A) The large quantities generated and the potential for leaching of heavy metals.
The management of fly ash is a significant environmental challenge due to the massive volumes produced by coal-fired power plants worldwide. Because fly ash contains concentrated amounts of heavy metals like arsenic, lead, and mercury, its improper disposal in ash ponds or unlined areas poses a high risk of groundwater contamination through leaching. Managing these large quantities while ensuring that toxic elements do not enter the ecosystem requires stringent environmental controls and proactive utilization strategies in construction and other industries to safely sequester these harmful substances.

144. (B) To prevent damage to the incinerator and to recover valuable resources.
Recovering materials like metals before incineration serves two critical purposes in a waste-to-energy facility. First, metals do not burn and provide no energy; if left in the waste, they can damage the furnace grates, clog systems, or contaminate the resulting ash. Second, metals like aluminum and steel are valuable resources that can be sold for recycling, providing an additional revenue stream. By removing these non-combustible materials, the facility improves the efficiency of the combustion process while maximizing the overall recovery of resources from the waste stream.

145. (B) Specific chemical characteristic testing
The calorific value, or heating value, of solid waste represents the amount of heat energy released during its complete combustion. While proximate and ultimate analyses provide information on components like moisture and elemental composition, the calorific value is usually determined through specific chemical testing using a bomb calorimeter. This parameter is critical for assessing the economic and technical feasibility of incineration and other thermal energy recovery processes. Accurate measurements of the energy content ensure that waste-to-energy plants are designed and operated to maximize power generation.

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146. (A) Ignitability
Ignitability is a hazardous waste characteristic that identifies materials capable of causing a fire during routine handling, storage, or transport. For liquid wastes, this is specifically defined by having a flash point—the lowest temperature at which vapors can ignite—below 60°C. This property makes the waste highly dangerous because it can catch fire easily under ambient conditions. Recognizing ignitability is essential for implementing strict fire safety protocols, using appropriate storage containers, and ensuring that the waste is kept away from heat sources and incompatible reactive materials.

147. (C) It facilitates the transfer of waste from smaller collection vehicles to larger transport vehicles.
A transfer station is a vital logistical facility in a municipal solid waste management system. Its main function is to act as a point of consolidation where multiple small collection trucks, which are efficient for residential pickups but costly

for long-distance travel, unload their waste. This waste is then compacted and reloaded into larger-capacity vehicles like semi-trailers or rail cars. This process significantly reduces the total number of trips required to reach distant disposal or processing sites, leading to substantial savings in fuel, labor, and transportation costs.

148. (A) (a), (b), (c), and (d) only
E-waste is a broad category that includes a wide range of discarded electrical and electronic products. Major sources include large household appliances like refrigerators and air conditioners, as well as consumer electronics like mobile phones, computers, and televisions. Specialty items such as fluorescent lamps also contribute to this waste stream. All these items require specialized management because they contain both hazardous substances and valuable materials. In contrast, kitchen scraps are organic wastes and do not fall under the classification of e-waste, requiring entirely different handling and treatment methods.

149. (B) Composting
Composting is a natural biological process that involves the controlled aerobic decomposition of organic matter by microorganisms like bacteria and fungi. In the presence of oxygen, these organisms break down materials such as food scraps and yard waste, transforming them into a stable, nutrient-rich, humus-like substance. This final product is an excellent soil conditioner that improves soil structure, fertility, and water retention. Composting is a key strategy for diverting organic waste from landfills and recycling nutrients back into the soil, promoting sustainable agricultural and landscaping practices.

150. (C) P-3, Q-1, R-4, S-2
The waste management hierarchy prioritizes actions based on their environmental benefits. Reduction involves using less material, such as minimizing packaging, while reuse focuses on extending product life, like using refillable bottles. Recycling refers to processing used materials into new products, such as making new paper from old paper. Recovery captures value from non-recyclable waste, typically through energy conversion. Understanding these levels through practical examples is essential for implementing sustainable waste strategies that maximize resource efficiency and minimize the overall volume of waste requiring final disposal.

151. (D) Vermicomposting
Biological methods of solid waste processing rely on the natural action of living organisms to decompose organic matter. Vermicomposting is a prime example, as it utilizes specific species of earthworms, along with microorganisms, to break down biodegradable waste into a high-quality organic fertilizer called vermicast. In contrast, incineration is a thermal process, shredding is a physical treatment, and landfilling is a method of final disposal. Because vermicomposting is driven by the digestive and metabolic processes of living creatures, it is classified as a biological waste management technology.

152. (A) It is a completely pollution-free process.
Incineration is a valuable waste treatment technology because it significantly reduces waste volume and can recover energy. However, it is not a pollution-free process. The combustion of mixed waste materials can release various air pollutants, including particulate matter, acidic gases, and highly toxic substances like dioxins and heavy metals. Furthermore, the process produces concentrated ash that must be managed as hazardous waste. Modern incinerators require sophisticated and expensive air pollution control systems to minimize their environmental impact, but some emissions and residues are inherent to the process.

153. (C) The volume of waste generated per pickup is large, justifying the transport of the entire container.
The economic feasibility of a Hauled Container System depends on the volume of waste at each collection point. This system is most efficient when a single location, such as a large construction site or industrial plant, generates a massive amount of waste that fills a large container. In such cases, the cost of transporting the entire container to the disposal site and back is justified by the large quantity of waste handled in a single trip. In contrast, for areas with small volumes, stationary systems that service multiple bins are more economical.

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154. (A) It can contaminate groundwater and surface water.
Leachate is the contaminated liquid that forms as water percolates through a landfill, dissolving various organic and inorganic pollutants. If a landfill lacks an effective liner and collection system, this toxic liquid can seep into the soil and reach underlying groundwater aquifers. It can also migrate into nearby surface water bodies. Because groundwater is a critical source of drinking water and leachate contains high concentrations of hazardous chemicals and pathogens, its uncontrolled release poses a severe threat to public health and the surrounding aquatic ecosystems.

155. (D) Silica (silicon dioxide)
Fly ash is a fine powdery residue primarily composed of mineral oxides that originate from the inorganic components of coal. Among these, silica is the most significant constituent, often making up a large portion of the material. This high silica content, along with alumina and iron oxides, gives fly ash its pozzolanic properties, allowing it to react with lime to form stable cementitious compounds. This characteristic is the reason fly ash is extensively used as a valuable additive in the production of high-performance concrete and durable construction bricks.

156. (C) c, a, d, b
Biomethanation through anaerobic digestion is a complex biological process that occurs in four sequential stages. It begins with hydrolysis, where complex organic polymers are broken down into simpler soluble compounds. This is followed by acidogenesis, where these compounds are converted into organic acids. Next, acetogenesis further transforms these acids into acetic acid, hydrogen, and carbon dioxide. Finally, methanogenesis occurs, where methanogenic bacteria convert these substrates into methane-rich biogas. This logical progression ensures the efficient conversion of biodegradable organic waste into a valuable renewable energy source.

157. (C) The diversity of plastic types makes sorting for recycling difficult.
Plastic waste management is technically challenging because plastic is a broad term covering many different polymer types, such as PET, HDPE, and PVC. Each resin has distinct chemical properties and melting points, meaning they cannot be recycled together without compromising the quality of the final product. Identifying and sorting these various plastics from a mixed waste stream is a labor-intensive and complex task. This requirement for precise segregation is a primary reason why large-scale plastic recycling is often difficult and expensive to implement effectively.

158. (D) Solidification encapsulates the waste, while stabilization aims to make it chemically less harmful.
While often used together, solidification and stabilization are distinct hazardous waste treatment processes. Stabilization involves chemical reactions that transform toxic constituents into more stable, less soluble, or less hazardous forms, directly reducing the chemical threat. Solidification, on the other hand, is a physical process that traps the waste within a solid, monolithic block or matrix, such as cement or asphalt. This physical binding reduces the surface area available for leaching and makes the waste easier to handle and dispose of securely in a hazardous waste landfill.

159. (A) A well-managed composting facility processing only food and yard waste
Hazardous waste originates from various industrial, commercial, and even domestic sources. Industries like metal plating and healthcare facilities like hospitals are major generators of hazardous byproducts. Even households contribute through items like batteries and paints. However, a properly managed composting facility that processes only organic biodegradable materials like food and garden trimmings is not a source of hazardous waste. Instead, it is a resource recovery facility that transforms non-hazardous organic matter into a beneficial soil amendment, provided the input stream is kept free of toxic contaminants.

160. (C) (a), (b) and (c) only
E-waste is a rapidly growing waste stream globally, characterized by its complex composition. It is a valuable resource containing precious metals like gold and silver, but it also contains highly toxic substances like lead and mercury. If recycled through informal methods, these hazardous materials can be released, posing severe

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health risks to workers and contaminating the environment. Therefore, the statements regarding its growth, the dangers of informal recycling, and its material value are correct. However, e-waste is certainly not harmless and requires specialized, regulated management for safe disposal.

161. (B) The system of bins or containers used for storing waste at the source before collection.
In the context of solid waste collection, a container system refers to the specific equipment and methods used to store waste at the point of generation before it is picked up by a collection vehicle. This includes the size, type, and location of the bins, as well as whether they are serviced individually or shared by multiple households or businesses. The design of the container system is a critical factor in determining the efficiency and cost-effectiveness of the overall municipal waste collection and transportation strategy.

162. (A) Volatile Matter
Proximate analysis is a standard analytical method used to characterize the physical composition of solid waste for energy recovery. It specifically determines four components: moisture content, volatile matter, fixed carbon, and ash residue. Volatile matter represents the part of the waste that vaporizes and burns as a gas when heated. This information is critical for designing incinerators and boilers, as it indicates how easily the waste will ignite and how much of it will burn in the gas phase rather than as a solid.

163. (C) Energy recovery
Energy recovery is a waste management strategy that focuses on capturing the latent energy stored in non-recyclable materials. A primary example is incineration, where solid waste is burned in a controlled furnace to generate heat. This heat is then used to produce steam, which drives turbines to generate electricity. This process provides a dual benefit: it significantly reduces the volume of waste that requires landfilling while simultaneously producing a renewable source of power. It is an essential component of integrated systems that aim to maximize resource utilization.

164. (D) The combined action of earthworms and microorganisms to decompose organic matter.
Vermicomposting is a unique biological waste treatment process that relies on the synergistic relationship between specific species of earthworms and a diverse population of microorganisms. The earthworms consume the organic matter, physically breaking it down and increasing its surface area. Inside the worm's digestive tract and in the surrounding environment, microorganisms continue the biochemical decomposition. This combined action results in the rapid transformation of organic waste into a stable, nutrient-rich soil amendment known as vermicast, which is highly beneficial for agricultural and gardening applications.

165. (C) Neutralization
For a large volume of highly acidic industrial effluent with a pH of 20, neutralization is the most appropriate and essential treatment method. This chemical process involves adding an alkaline substance, such as lime or caustic soda, to the acidic waste to raise its pH toward a neutral value of 7.0. Neutralization makes the effluent safer for discharge or subsequent treatment steps by eliminating its corrosive potential. It is a fundamental technique used across various industries to ensure that acidic liquid wastes do not damage equipment or harm the environment.

166. (B) It can be ingested by marine animals, causing injury or death, and can break down into microplastics.
The presence of plastic waste in marine environments poses a severe threat to aquatic biodiversity and ecosystem health. Marine animals often mistake plastic debris for food, leading to internal blockages, injuries, or starvation. Entanglement in plastic nets and lines also causes widespread mortality. Furthermore, as plastics are exposed to sunlight and waves, they break down into tiny microplastics. These particles can be ingested by a wide range of organisms, potentially introducing toxic chemicals into the marine food chain and ultimately impacting human health through seafood consumption.

167. (D) Waste recycling and reuse
Utilizing fly ash from thermal power plants as a raw material for brick manufacturing is a classic

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example of waste recycling and reuse. Instead of being disposed of in landfills or ash ponds, where it could cause environmental pollution, the fly ash is treated as a valuable resource. By incorporating it into building materials, the industry reduces the need for virgin clay and other natural resources while sequestering the ash in a stable, useful product. This practice supports the circular economy and promotes sustainable industrial development.

168. (D) Both (A) and (B).
In the optimization of solid waste collection routes, U-turns are avoided as much as possible for both safety and efficiency reasons. Executing a U-turn with a large collection vehicle is difficult and increases the risk of traffic accidents. Furthermore, U-turns are considered non-productive activities because no waste is being collected during the maneuver, leading to wasted time and increased fuel consumption. Designing routes that follow more linear or looped paths ensures a smoother operation and reduces the overall cost and time required for waste collection.

169. (C) Exposure to toxic substances like heavy metals and flame retardants.
The informal recycling of e-waste often involves hazardous practices such as manual dismantling and open-air burning to recover metals. These activities expose workers and nearby communities to a wide range of toxic substances, including heavy metals like lead, mercury, and cadmium, as well as hazardous flame retardants and dioxins. These pollutants can enter the body through inhalation or skin contact, leading to severe health problems such as neurological damage, respiratory illnesses, and cancer. The lack of proper safety equipment and environmental controls makes this a major public health concern.

170. (A) A large roll-off container at a construction site that is transported to a landfill when full.
A Hauled Container System is characterized by the movement of an entire storage container to a disposal or processing site. A common example is a large roll-off bin used at a construction or demolition site. When the bin is full, a specialized truck picks it up, hauls it to the landfill to be emptied, and then either returns it to the site or replaces it with an empty unit. This system is ideal for handling high volumes of waste generated at a single location in a short time.

171. (A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
Biomethanation is a versatile technology that addresses both waste disposal and resource recovery. The process uses anaerobic digestion to break down the organic fraction of solid waste, producing methane-rich biogas which can be used as a combustible fuel for heating or electricity. Additionally, the solid and liquid residue, known as digestate, is rich in nutrients and serves as an excellent organic fertilizer. Because both the assertion and the reason correctly highlight these dual benefits and the underlying mechanism, they are both accurate and logically linked.

172. (B) Minimize water infiltration and support surface vegetation.
The final cover, or cap, of a sanitary landfill is a multi-layered system installed once the landfill has reached its full capacity. Its primary engineering function is to minimize the amount of rainwater that infiltrates the waste mass, thereby reducing the ongoing generation of leachate. Additionally, the top layer of the cover is designed to support the growth of vegetation, which helps stabilize the surface, prevents erosion, and improves the aesthetic integration of the closed site into the surrounding landscape, ensuring long-term environmental protection.

173. (C) Its pozzolanic properties
Fly ash is highly valued in the concrete industry because of its pozzolanic properties. When mixed with Portland cement and water, the fine particles of fly ash react with calcium hydroxide to form stable compounds that possess cementitious properties. This reaction enhances the long-term strength and durability of the concrete while improving its workability and reducing its permeability. By replacing a portion of the cement with fly ash, construction projects can achieve better structural performance while also contributing to sustainable waste management and reducing overall carbon emissions.

174. (D) Statement I is false but Statement II is true.
While many plastics are theoretically recyclable, the practical reality of large-scale recycling is highly complex. The presence of different

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to their bulky nature, they cannot be collected through standard municipal waste streams and require specialized recycling and disposal procedures. Proper management involves recovering valuable metals while safely handling hazardous components like refrigerants and insulation materials.

188. (B) The time spent traveling from the garage to the start of the route and from the end of the route to the disposal site.
In the context of waste collection logistics, dead-head time refers to the periods when a collection vehicle is in transit but is not actively picking up waste. This includes the initial travel from the municipal garage to the first collection point, and the final trip from the end of the collection route to the transfer station or disposal facility. Minimizing dead-head time through careful route optimization is essential for reducing fuel consumption, labor costs, and the overall time required for a collection shift, thereby improving the efficiency of the system.

189. (C) Solidification
Solidification is a hazardous waste treatment process that focuses on improving the physical handling characteristics of the waste and reducing its environmental mobility. It involves mixing the waste with a binding agent, such as cement, lime, or asphalt, which cures to form a solid, monolithic block or matrix. By encapsulating the hazardous constituents within this stable structure, the process physically prevents the contaminants from leaching out into the environment. This is a critical step for preparing hazardous residues for safe disposal in a secure landfill facility.

190. (C) (a), (b) and (c) only
A sanitary landfill is an engineered facility designed to isolate waste from the environment through specific technical controls. Key features include an impermeable liner system to prevent groundwater contamination from leachate and a daily soil cover to manage odors and pests. While it is a highly controlled method of disposal, the anaerobic decomposition of organic waste within the landfill inevitably produces greenhouse gases like methane and carbon dioxide. Therefore, statements regarding its engineered design, liners, and daily cover are correct, but the claim that it produces no greenhouse gases is false.

191. (A) Thermal processes like combustion
Proximate analysis is a critical tool for evaluating the suitability of solid waste as a fuel for thermal treatment. By measuring moisture, volatile matter, fixed carbon, and ash content, engineers can determine how the waste will behave in a furnace or incinerator. For example, high volatile matter content suggests easier ignition and a greater contribution to flaming combustion. These parameters are essential for designing combustion chambers, sizing air pollution control systems, and calculating the net energy recovery potential from waste-to-energy projects.

192. (B) Density
Hazardous waste is identified by specific properties that indicate an inherent danger to human health or the environment, namely ignitability, corrosivity, reactivity, and toxicity. These characteristics dictate how the waste must be stored, treated, and disposed of to ensure safety. In contrast, density is a physical characteristic that represents the mass per unit volume of the waste. While density is important for logistical planning, such as determining vehicle capacity and landfill life, it is not a criteria used to classify a waste as hazardous.

193. (B) Anaerobic conditions
Biomethanation is a biological waste treatment technology that relies on the activity of specific microorganisms working in anaerobic conditions. This means the decomposition process must take place in a sealed environment that is completely devoid of oxygen. Under these conditions, anaerobic bacteria break down biodegradable organic matter, such as food waste or sewage sludge, to produce methane-rich biogas. This differentiates it from composting, which is an aerobic process. Biomethanation is a valuable way to simultaneously treat organic waste and generate renewable energy from the resulting methane.

194. (A) Use as a fuel in energy recovery facilities (e.g., cement kilns).
Non-biodegradable and non-recyclable plastic wastes with high energy content pose a significant disposal challenge. Because they cannot be composted or easily recycled into new products, the most appropriate management option is energy recovery through co-processing.

crushed and reused as construction aggregate, promoting resource efficiency.

181. (C) To create a uniform, densified, and easy-to-transport fuel with a consistent heating value.
The production of fuel pellets from municipal solid waste involves a series of processing steps including drying, shredding, and the removal of non-combustible materials. The primary goal is to transform heterogeneous and bulky waste into a densified, uniform product. These pellets have a significantly higher and more consistent calorific value than raw waste, making them a much more efficient fuel for industrial boilers and power plants. Their compact shape also facilitates easier storage and more economical long-distance transportation, enhancing the feasibility of waste-to-energy projects.

182. (A) A significant reduction in energy consumption.
Recycling aluminum is one of the most environmentally beneficial resource recovery processes. Producing aluminum from recycled cans requires only about five percent of the energy needed to extract and refine primary aluminum from bauxite ore. This massive energy saving directly leads to a significant reduction in greenhouse gas emissions and other environmental impacts associated with mining and smelting operations. Because aluminum can be recycled repeatedly without losing its properties, this process is a cornerstone of sustainable materials management and the circular economy.

183. (D) pH level
Corrosivity is a hazardous waste characteristic that identifies materials capable of causing serious damage to living tissue or aggressively attacking metals. This property is primarily measured by the pH level of an aqueous waste sample. Wastes with extremely low pH values, indicating high acidity, or very high pH values, indicating high alkalinity, are classified as corrosive. Specifically, a pH less than or equal to 20 or greater than or equal to 125 defines a waste as corrosive, requiring specialized storage containers and careful neutralization before disposal.

184. (A) To safely control the release of methane and other gases produced during decomposition.
As organic waste decomposes anaerobically in a sanitary landfill, it generates landfill gas, which is primarily composed of methane and carbon dioxide. A gas venting system is installed to provide a controlled pathway for these gases to escape the waste mass. Without proper venting, gas can build up pressure, leading to the risk of explosions or uncontrolled migration into surrounding soil and buildings. By safely directing the gas to the surface, it can be flared or captured for use as a renewable energy source.

185. (C) It persists in the environment for hundreds of years.
Most common plastics are manufactured from synthetic polymers that are specifically designed for durability and are not recognized by the natural enzymes of microorganisms. As a result, they do not biodegrade and instead persist in the environment for centuries. While they may physically break down into smaller microplastics due to sunlight and wave action, the material itself remains as a long-term pollutant. This persistence leads to widespread accumulation in landfills and oceans, posing ongoing threats to wildlife and contaminating global ecosystems for generations.

186. (A) Coal-fired thermal power plants
Fly ash is a fine, powdery mineral residue that is a major byproduct of the electricity generation process in coal-fired thermal power plants. It is formed when pulverized coal is burned at high temperatures, causing the non-combustible inorganic impurities to melt and be carried out of the furnace by flue gases. These particles are kemudian captured by air pollution control devices, such as electrostatic precipitators, before they can be released into the atmosphere. Due to the massive scale of coal combustion, fly ash management is a critical environmental concern.

187. (D) E-waste or bulky waste
Large household appliances such as refrigerators, washing machines, and air conditioners are often referred to as white goods. These items are classified under the broad categories of e-waste or bulky waste because of their size, complex material composition, and the presence of both electrical components and various metals. Due

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Hazardous wastes are classified according to specific dangerous properties. Toxicity refers to materials that can cause acute or chronic harm, or even death, to humans or wildlife when they are ingested, inhaled, or absorbed through the skin. This characteristic is often determined through standardized laboratory tests. In contrast, ignitability refers to fire risk, corrosivity is determined by extreme pH levels, and reactivity involves unstable chemical behavior. Correctly identifying these properties is essential for ensuring the safe handling, transport, and disposal of hazardous industrial and domestic by products.

215. (D) Composting
Composting is a biological process designed specifically for the decomposition of organic, biodegradable materials. The presence of non-biodegradable materials such as plastics, glass, and metals in the waste stream makes the composting process highly inefficient and difficult to manage. These inert materials do not break down and must be manually or mechanically removed, which is often costly and incomplete. Without effective source segregation to provide a clean organic input, the final compost will be of poor quality and contaminated, severely limiting its usefulness in agriculture or landscaping.

216. (A) Refuse Derived Fuel (RDF)
Fuel pellets are a densified form of Refuse Derived Fuel produced by processing municipal solid waste. The production involves drying the waste, removing non-combustible components like glass and stones, and then shredding and compacting the energy-rich fraction into uniform pellets. These pellets have a high and consistent calorific value, making them much more efficient for use in industrial boilers and power plants than raw, heterogeneous waste. The conversion of MSW into RDF pellets is an effective strategy for maximizing energy recovery from the combustible portion of the waste stream.

217. (C) Obsolete computers and mobile phones
E-waste is a specialized waste stream that originates from discarded electrical and electronic equipment. Obsolete computers and mobile phones are major contributors to this category because of their short lifecycles and high rates of technological replacement. These devices are complex, containing valuable precious metals along with hazardous substances like lead and mercury. Proper management of e-waste is critical to recover these resources while preventing toxic contamination. In contrast, packaging and food wastes fall into different municipal waste categories and require entirely different handling and treatment strategies.

218. (A) Silicon, Aluminum, and Iron
Fly ash is a complex mineral residue formed during the high-temperature combustion of coal in thermal power plants. Its chemical composition is dominated by various inorganic oxides that were present in the coal's mineral matter. The three most prevalent constituents are the oxides of silicon, aluminum, and iron, which typically make up the majority of the material's weight. These oxides are responsible for the pozzolanic properties of fly ash, enabling it to react with lime to form stable cementitious compounds. This makes fly ash a valuable and widely used industrial by product.

219. (D) The leaching of heavy metals like lead and mercury into groundwater.
Disposing of untreated e-waste in unlined landfills poses a significant environmental risk due to the presence of various toxic materials. Electronic components often contain heavy metals like lead and mercury, as well as hazardous flame retardants. Over time, as water percolates through the landfill, these substances can be leached out of the devices and migrate into the underlying soil and groundwater aquifers. This contamination can persist for decades, introducing dangerous toxins into local water supplies and the broader food chain, potentially causing severe long-term health impacts.

220. (B) Using it as a raw material in cement manufacturing.
The utilization of fly ash involves finding productive engineering or industrial applications for this major by product of coal combustion. A primary example of such utilization is using fly ash as a raw material in the manufacturing of cement. Because of its pozzolanic properties, fly ash can replace a portion of the traditional clinker, improving the quality and sustainability of the final cement product. This practice diverts massive volumes of ash from disposal

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This involves using the plastic as an alternative fuel in high-temperature industrial processes, such as cement kilns. This approach effectively captures the calorific value of the waste, reducing the consumption of fossil fuels while ensuring the complete thermal destruction of the plastic in a controlled, energy-efficient manner.

195. (C) Statement I is true but Statement II is false.
Fly ash is a versatile material frequently used in land reclamation and for filling low-lying areas due to its stable physical properties. This makes Statement I correct. However, while fly ash can be used in agriculture to improve soil texture and provide some micronutrients, its application is not always beneficial. Fly ash often contains heavy metals that can accumulate in the soil and be absorbed by crops, potentially entering the food chain. Therefore, Statement II is false as it ignores the necessary precautions regarding the chemical safety of fly ash.

196. (D) Minimize the total time and distance for the collection round trip.
The primary goal of optimizing a solid waste collection route is to maximize the efficiency of the entire operation. By using specialized software or logistical principles to design the most direct paths, municipalities can significantly reduce the total distance traveled and the time taken for each collection shift. This leads to substantial savings in fuel costs, vehicle maintenance, and labor hours. An optimized route ensures that all waste is collected reliably while minimizing the environmental footprint and operational expenses of the municipal waste management fleet.

197. (B) Neurological and developmental damage
Long-term exposure to lead, a common toxic element in e-waste, has severe health consequences, particularly for the central nervous system. In informal recycling settings where lead is released through burning or improper dismantling, it can be inhaled or ingested. Lead exposure is especially dangerous for children, as it can cause permanent neurological damage, leading to developmental delays, lower IQ, and behavioral problems. In adults, it can cause high blood pressure and kidney damage. This underscores the urgent need for formal, safe e-waste management to protect vulnerable populations.

198. (A) Disposal in a secure landfill
The residues from waste treatment processes, such as ash from incinerators and stabilized materials from hazardous waste treatment, often contain concentrated amounts of toxic constituents that cannot be further broken down. The final step in their management is disposal in a secure landfill. These specialized facilities are designed with multiple liners and advanced monitoring systems to ensure that these hazardous residues are permanently isolated from the environment. This ensures that any remaining risks to public health and groundwater are neutralized through long-term, engineered containment.

199. (D) The combustible components of municipal solid waste, such as plastic and paper.
Refuse Derived Fuel is a highly processed material produced from the non-recyclable combustible fraction of municipal solid waste. It is primarily composed of high-energy components such as discarded paper, cardboard, and various plastics. During production, these materials are shredded and dried to remove moisture and non-combustible items like glass and metals. This results in a concentrated and uniform fuel that can be used as a substitute for coal or other fossil fuels in industrial boilers, providing an effective way to recover energy from discarded materials.

200. (A) Vermicomposting - Involves earthworms
Vermicomposting is correctly identified as a biological decomposition process that specifically utilizes earthworms, along with microorganisms, to break down organic waste into a nutrient-rich soil amendment called vermicast. In contrast, composting is primarily an aerobic process, incineration is a thermal (not biological) process, and landfilling is a final disposal method rather than primarily an energy generation process. Understanding these fundamental characteristics is essential for selecting the appropriate technology for managing different types of waste and maximizing the efficiency of resource recovery.

201. (C) (A) is correct but (R) is not correct.
Improperly managed plastic waste is a major threat to marine ecosystems because it persists

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polymer types, various chemical additives, and contamination from food or other wastes makes it difficult and expensive to produce high-quality recycled products. Therefore, Statement I is false as it oversimplifies the ease of the process. Statement II is correct, as it accurately identifies the technical and economic challenges, such as sorting and material purity, that limit the efficiency and widespread adoption of plastic recycling globally.

175. (A) An incinerator
Ultimate analysis provides critical data on the elemental composition of solid waste, specifically the percentages of carbon, hydrogen, oxygen, nitrogen, and sulfur. This information is essential for the precise engineering design of an incinerator. It allows for the calculation of the stoichiometric air required for complete combustion and the prediction of the chemical makeup of flue gases. This ensures that the furnace and its air pollution control systems are correctly sized and equipped to manage emissions like sulfur oxides and nitrogen oxides, ensuring safe and efficient operation.

176. (B) Waste paper and cardboard
Hazardous wastes are defined by specific dangerous properties such as toxicity, corrosivity, or flammability. Spent solvents, car batteries containing lead and acid, and pesticide residues are all examples of hazardous waste because they pose significant threats to health and the environment. In contrast, waste paper and cardboard are generally non-hazardous municipal materials. They are primarily composed of cellulose and are easily managed through standard recycling processes or composting. Unless contaminated with toxic substances, paper products are not classified as hazardous and do not require specialized safety protocols.

177. (B) Dissolved heavy metals
Precipitation is a chemical treatment process specifically designed to remove dissolved inorganic contaminants, particularly heavy metals like lead, mercury, and cadmium, from liquid hazardous waste streams. By adding specific reagents that react with these metal ions, they are converted into insoluble solid particles that settle out of the solution as a sludge. This process effectively separates the toxic metals from the wastewater, allowing the treated liquid to be safely handled and preventing the harmful release of heavy metals into the natural environment or municipal sewage systems.

178. (C) (a), (b), (c), and (d) only
An effective e-waste management system requires multiple integrated components to ensure resource recovery and environmental safety. This includes collection mechanisms like take-back schemes, formal facilities for safe dismantling, and a clear policy framework such as Extended Producer Responsibility. Public awareness is also critical to ensure participation. However, open burning is an extremely hazardous and prohibited practice that releases toxic pollutants. Therefore, an effective management system excludes such harmful activities and instead focuses on regulated, environmentally sound practices that minimize risks to human health and the environment.

179. (C) Likely to decompose rapidly and cause odors.
In waste management, the term putrescible refers to organic materials that are highly susceptible to rapid biological decomposition. This category primarily includes food residues and animal products that are broken down by microorganisms in a short period. Because these materials have high moisture and protein content, their decomposition often results in the release of foul-smelling gases and attracts pests like flies and rodents. Managing putrescible waste requires frequent collection or prompt treatment through methods like composting or biomethanation to prevent sanitation problems and environmental nuisances.

180. (B) P-3, Q-1, R-2, S-4
Proper waste management involves selecting treatment methods tailored to the specific properties of each waste component. Wet organic food waste is best managed through biological processes like composting or biomethanation to recover nutrients or energy. Dry paper and cardboard are highly recyclable materials that should be returned to the production cycle. Discarded tires can be used for energy recovery in cement kilns or through pyrolysis. Demolition debris consists of inert materials that can be

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This ensures that the waste management system remains economically efficient and operationally manageable for the city.

208. (B) Nitrogen
Proximate analysis and ultimate analysis provide different levels of detail about the composition of solid waste. Proximate analysis measures physical categories like moisture, volatile matter, fixed carbon, and ash. Ultimate analysis, however, determines the elemental composition of the waste, specifically measuring the percentages of carbon, hydrogen, oxygen, nitrogen, and sulfur. Therefore, nitrogen is a specific element identified through ultimate analysis that is not included in a standard proximate analysis. Understanding the nitrogen content is critical for predicting potential emissions like nitrogen oxides during thermal treatment processes.

209. (B) Contamination of the final product with non-biodegradable items like plastics and glass.
Composting mixed municipal solid waste often fails because the input material is not segregated at the source. The resulting compost is frequently contaminated with small pieces of plastic, glass, and metals, which are impossible to remove completely through mechanical means. This contamination reduces the quality of the final product, makes it unsuitable for agricultural use, and lowers its market value. Without high-quality, segregated organic waste as an input, composting facilities struggle to produce a viable product and maintain economic sustainability, leading to operational failure in many urban settings.

210. (A) P-4, Q-1, R-3, S-2
E-waste is composed of diverse materials that require different management approaches. Circuit boards are complex assemblies containing various materials, while plastic casings are polymers. Copper wires are valuable metals that are highly sought after for recycling. Lead in solder is a hazardous substance that poses significant health and environmental risks if not handled correctly. Correctly categorizing these components is essential for designing effective e-waste recycling programs that maximize the recovery of valuable resources while ensuring the safe management of toxic constituents within a regulated facility.

211. (A) To act as an impermeable barrier to contain leachate.
A geomembrane liner is a critical engineering component in the design of modern sanitary landfills. It is a high-density synthetic membrane that is installed as part of the bottom liner system to create an impermeable barrier. Its primary function is to contain the leachate—the contaminated liquid produced by the decomposing waste—and prevent it from migrating into the underlying soil and groundwater aquifers. This containment is essential for ensuring that the disposal facility does not cause long-term environmental pollution or threaten local water resources and public health.

212. (D) It is a much faster process and produces a higher quality compost (vermicast).
Vermicomposting offers significant advantages over traditional composting for managing organic waste. By using specialized species of earthworms to physically break down and process the material, the decomposition occurs much more rapidly. Furthermore, the action of the worms' digestive systems and the associated beneficial microorganisms produces vermicast, which is often superior in quality to traditional compost, with higher levels of available plant nutrients and improved soil-enhancing properties. This makes vermicomposting a highly efficient and decentralized solution for producing premium organic fertilizer from various biodegradable waste streams.

213. (C) Incineration
The heating value, or calorific value, of solid waste is the most important parameter for evaluating its suitability for incineration. It represents the total amount of energy that can be recovered from the waste through controlled combustion. A high heating value indicates that the waste can sustain combustion and provide enough energy to generate electricity or steam. In contrast, processes like composting or recycling rely on different physical and chemical properties. Accurate knowledge of the energy content is essential for designing and operating efficient waste-to-energy facilities.

214. (A) Toxicity – harmful or fatal when ingested or absorbed.

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for centuries, entangles wildlife, and breaks down into microplastics that enter the food chain. However, the claim that plastics are readily biodegradable in seawater is completely incorrect; in fact, their durability and lack of natural degradation are the primary reasons for their environmental impact. Since plastics do not break down into nutrients, they do not cause eutrophication. Therefore, the assertion is correct about the environmental threat, but the reason given is factually false.

202. (A) Kilograms per capita per day
The waste generation rate is a fundamental metric used in municipal planning to quantify the amount of waste produced by a population over a specific time. It is most commonly expressed in kilograms per capita per day. This unit allows planners to estimate total waste volumes based on population size, which is essential for determining the required capacity for collection vehicles, transport systems, and disposal facilities. Accurate generation data help cities manage their resources effectively and design sustainable waste management strategies tailored to their specific urban needs.

203. (D) Incineration or autoclaving followed by secure landfilling
Biomedical waste, particularly human anatomical waste and sharp instruments, poses unique infectious and physical risks that require specialized disposal methods. Incineration at high temperatures is highly effective for destroying pathogens and reducing the volume of organic materials. Alternatively, autoclaving uses high-pressure steam for sterilization. After these treatments, the residual waste must be disposed of in a secure landfill to prevent any remaining risks to public health. These stringent protocols ensure that infectious materials are neutralized and permanently isolated from the environment and the general waste stream.

204. (B) Methane and Carbon Dioxide
Landfill gas is a major byproduct of the anaerobic decomposition of organic matter that occurs within the waste mass of a landfill. It is primarily composed of approximately 50 percent methane and 50 percent carbon dioxide, with trace amounts of other gases. Methane is a potent greenhouse gas that can also be a valuable energy source if captured. Understanding the composition of this gas is critical for landfill operators to manage environmental impacts, prevent fires or explosions, and design systems for potential energy recovery or safe atmospheric venting.

205. (B) (b), (c), and (d) only
Sustainable plastic waste management relies on multiple integrated strategies. Implementing Extended Producer Responsibility ensures that manufacturers take ownership of the end-of-life management of their products. Encouraging source segregation is vital for obtaining high-quality material for recycling, while co-processing provides a path for energy recovery from non-recyclable plastics. In contrast, promoting single-use plastics or disposing of all plastics without segregation are environmentally harmful practices. Therefore, only the statements focused on EPR, source segregation, and infrastructure for recycling and co-processing correctly describe effective management strategies.

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206. (D) Composting or biomethanation
For a solid waste sample with high moisture and organic content, biological treatment methods are the most technically and economically suitable options. Composting utilizes aerobic microorganisms to decompose the waste into a stable soil amendment, while biomethanation uses anaerobic digestion to produce biogas and digestate. These processes thrive on the biodegradable nature of the organic matter and are not hindered by high moisture, unlike incineration, which requires dry materials for efficient combustion. These methods provide a sustainable way to recycle nutrients or recover energy from wet organic waste streams.

207. (A) A point of consolidation to reduce transport costs to distant disposal sites.
A transfer station serves as a critical intermediate facility in the logistical chain of municipal solid waste management. Its primary function is to consolidate waste from smaller, local collection vehicles into much larger, high-capacity transport trucks or rail cars. This process of consolidation is essential for reducing the total number of trips and overall transportation costs when final disposal or processing sites are located at a significant distance from the urban center.

sites, reduces the carbon footprint of cement production, and demonstrates a successful model for resource-efficient waste management.

221. (A) b, d, a, c
The waste management hierarchy provides a prioritized framework for sustainable waste handling based on environmental impact. The most preferred option is source reduction, which prevents waste before it is generated. This is followed by reuse, which extends the life of products. If these are not possible, energy recovery through methods like incineration is preferred over final disposal. Landfilling is the least preferred option and should only be used for the remaining residual waste. This sequence ensures that resource efficiency is maximized while minimizing the volume of waste sent to landfills.

222. (D) Non-biodegradability and persistence
The primary environmental concern regarding plastic waste is its extreme durability and lack of natural biodegradation. Most synthetic plastics are designed for long-term use and are not recognized by the enzymes of decomposing microorganisms. Consequently, once plastic enters the environment, it persists for hundreds of years. This persistence leads to the massive accumulation of plastic debris in oceans and soil, where it can break down into micro plastics but remains as a permanent pollutant. This long-term presence poses continuous threats to wildlife and global ecosystem health across the world.

223. (A) To raise the pH towards a neutral value (around 7).
Neutralization is a chemical treatment process used to manage hazardous wastes that are highly acidic. By adding a neutralizing agent like lime, which is alkaline, a chemical reaction occurs that raises the pH of the waste toward a neutral value of approximately 7.0. This process eliminates the corrosive potential of the acid, making the waste safer for further treatment or final disposal. Neutralization can also help in the precipitation of dissolved heavy metals, providing an essential step in ensuring that industrial effluents do not harm infrastructure or the environment.

224. (B) Land application as a soil fertilizer
Proper e-waste management focuses on resource recovery and pollution prevention through specialized methods. These include refurbishing and reusing functional devices, controlled recycling for precious metal recovery, and secure land filling of non-recyclable residues. However, e-waste is never used for land application as a fertilizer. Unlike organic waste, electronics contain a wide range of toxic substances like lead, mercury, and flame retardants. Applying e-waste to soil would cause severe and long-term contamination of the land and water, posing grave risks to agriculture and public health in the area.

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225. (A) (a) and (c) only
Effective management of plastic waste requires strategies that address both reduction and resource recovery. Source reduction, such as using less packaging, is the most preferred method as it prevents waste generation. For plastics that cannot be recycled economically, co-processing in cement kilns provides a beneficial way to recover energy while ensuring complete thermal destruction. However, mixing all types of plastics hinders high-quality recycling, and plastic waste certainly does not improve aesthetics. Therefore, only the statements regarding source reduction and co-processing are accurate descriptions of sustainable plastic management practices.

226. (A) A contaminated liquid that seeps through the waste.
Leachate is a highly contaminated liquid by product formed when water, typically from rainfall, percolates through the buried waste in a landfill. As the water moves through the material, it dissolves a complex mixture of organic and inorganic chemicals and picks up various pathogens and suspended solids. If not properly collected by a liner and drainage system, leachate can migrate into the soil and reach underlying groundwater aquifers, posing a severe threat to public health and the environment. Managing this toxic liquid is a critical requirement for all sanitary landfills.

227. (C) Chemical characteristics
The energy content, or calorific value, of solid waste is a fundamental parameter used to assess its potential for energy recovery through thermal treatment. This value represents the amount of

288. (B) The significant reduction in waste volume.
Incineration is a thermal treatment process that uses high temperatures to burn combustible materials. Its most prominent benefit is the drastic reduction in the physical volume of the waste, often by up to ninety percent. This significant shrinkage lessens the demand for landfill space, extending the operational life of existing disposal sites and making waste management more spatially efficient.

289. (D) A contaminated liquid formed by water percolating through waste.
Leachate is a byproduct of the landfilling process that occurs when moisture, such as rainwater, filters through the layers of buried waste. As the water moves downward, it dissolves various chemical and biological substances, becoming a highly contaminated liquid. Proper management of this fluid is essential, as it poses a serious threat to groundwater quality if not contained.

290. (A) The need to manage air emissions and dispose of ash residue.
Operating an incinerator involves addressing complex environmental concerns. The high-temperature combustion can release harmful air pollutants, requiring advanced filtration systems to protect public health. Furthermore, the process leaves behind ash that may contain concentrated toxic elements. This residual material must be carefully handled and often requires disposal in specialized facilities designed to prevent the leaching of hazardous contaminants.

291. (C) Neutralization
Liquid waste with a low pH is highly acidic and potentially corrosive. To handle this material safely, the management process begins with neutralization. This chemical treatment involves adding basic substances to the waste to raise its pH toward a neutral range. Stabilizing the acidity is a critical first step that renders the waste less hazardous and prepares it for further processing.

292. (A) To immobilize hazardous components and reduce their leachability
Solidification and stabilization techniques are used to manage hazardous materials that cannot be easily destroyed. By mixing waste with binders like cement, the toxic elements are trapped within a stable, solid structure. This immobilization prevents harmful substances from dissolving in water and leaking into the environment over time. The primary goal is to ensure the waste remains safe.

293. (D) Oxidation-reduction
Chemical transformation is a key method for reducing waste toxicity. The conversion of hexavalent chromium to its trivalent state is achieved through oxidation-reduction reactions. In this process, the chemical properties of the substance are altered by the transfer of electrons. This specific reaction is valuable because it turns a highly toxic and mobile pollutant into a safer form.

294. (B) Radioactivity
The classification of hazardous waste depends on identifying specific dangerous properties. The text lists ignitability, corrosivity, reactivity, and toxicity as the fundamental traits that pose risks to health and the environment. While radioactivity is a hazardous property in many contexts, it is not included among the specific characteristics mentioned in the provided discussion of specialized hazardous waste management protocols.

295. (C) Certain organic hazardous wastes, with strict emission controls.
High-temperature incineration is an effective tool for the destruction of specific types of hazardous materials, particularly organic compounds. The intense heat breaks down complex molecular structures, neutralizing their dangerous properties. However, this method is not universal and requires rigorous environmental safeguards. Strict control of gaseous emissions is mandatory to prevent the release of secondary pollutants into the atmosphere.

296. (D) Coal combustion in thermal power plants
Fly ash is a fine, particulate material generated during industrial processes. Its primary origin is the combustion of coal within thermal power stations used for electricity generation. As the coal burns, these tiny particles are captured from the flue gases. Because of its massive production volume, finding productive uses for this ash is a major priority in waste management.

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Both processes are aerobic and result in organic fertilizers, but their biological pathways and the specific roles played by the different organisms involved are fundamentally different.

234. (A) The mobility of toxic contaminants, simulating landfill leaching.
The Toxicity Characteristic Leaching Procedure is a standard laboratory test used to identify hazardous waste that could pose a threat to groundwater. The procedure simulates the conditions that waste would experience in a landfill environment, specifically how easily toxic constituents can leach out of the material into water. If the concentration of certain contaminants in the resulting leachate exceeds specific regulatory limits, the waste is classified as hazardous. This test is essential for determining the correct management and disposal requirements for various industrial and chemical waste materials.

235. (D) Facilitate targeted recycling and proper handling of hazardous components.
Having separate collection streams for different categories of e-waste is essential for effective resource recovery and environmental safety. Different electronic products contain different mixtures of valuable materials and toxic substances. For example, CRT monitors contain high levels of lead, while refrigerators contain refrigerants. By segregating these items at the collection stage, recyclables can be sent to specialized facilities that are equipped to safely handle the specific hazardous components and efficiently recover valuable metals. This targeted approach maximizes the overall effectiveness and safety of the e-waste management system.

236. (B) The processing of waste materials to make the same or different products.
Recycling is a core component of the circular economy, focusing on the systematic recovery and processing of discarded materials into new usable goods. This process involves collecting, sorting, and transforming waste—such as paper, glass, metals, and certain plastics—into raw materials for manufacturing. These materials can be used to make the same product, such as new glass bottles from old ones, or entirely different items. Recycling helps conserve natural resources, reduces the energy needed for production, and decreases the volume of waste requiring disposal in landfills or incinerators.

237. (C) The non-volatile, combustible material remaining after driving off volatile matter.
During the proximate analysis of solid waste, fixed carbon represents the solid combustible residue that remains after the moisture and volatile matter have been evaporated. It is a key indicator of the energy potential of the waste that can be burned in the solid phase. Fixed carbon content is determined by subtracting the percentages of moisture, volatile matter, and ash from the total sample weight. This parameter is particularly important for designing systems for charcoal production, gasification, or for understanding the long-duration heat output of the waste during thermal treatment.

238. (D) Release of toxic pollutants like dioxins, furans, and particulate matter.
The open burning of mixed solid waste is a major public health hazard because it occurs at low temperatures and without any environmental controls. This incomplete combustion of diverse materials, especially plastics and various chemicals, results in the release of highly toxic pollutants. These include persistent organic pollutants like dioxins and furans, as well as high concentrations of fine particulate matter and heavy metal vapors. Inhaling these substances can cause severe respiratory illnesses, neurological damage, and cancer, highlighting the urgent need for controlled waste management and disposal.

239. (A) Changes the physical properties of the waste to make it a solid block.
Solidification is a hazardous waste treatment method that primarily focuses on improving the physical stability and handling characteristics of the waste. It involves mixing the hazardous material with a binding agent, such as cement, asphalt, or polymers, which then cures to form a solid, monolithic block or matrix. By physically binding the waste within this stable structure, the process reduces its surface area and prevents the hazardous constituents from migrating or leaching into the environment. This makes the waste safer for disposal in an engineered, secure landfill facility.

240. (A) (a), (b), (c), and (d) only

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Fly ash is a versatile industrial by product with multiple engineering and agricultural applications. Its pozzolanic properties make it an excellent partial replacement for cement in concrete and a suitable material for constructing stable road embankments. It is also used as a filler in plastics and as a soil conditioner to improve texture. However, because it contains heavy metals and lacks nutrients, it is never used as a food source for livestock. Therefore, only the statements regarding its construction, industrial, and agricultural uses are correct descriptions of its utilization pathways.

241. (B) A slow composting process due to nitrogen deficiency for microorganisms.
The carbon-to-nitrogen ratio is a critical factor in determining the speed and effectiveness of the composting process. Microorganisms require nitrogen to build cellular proteins and grow their populations. If the initial organic mixture has a high C/N ratio, it means there is an excess of carbon and a relative deficiency of nitrogen. This lack of essential nitrogen severely limits the activity of the decomposing bacteria and fungi, resulting in a significantly slower composting process. Ensuring a proper nutrient balance is essential for achieving efficient and rapid biological decomposition.

242. (A) Convert toxic substances to less toxic forms by changing their chemical state (e.g., Cr^{6+} to Cr^{3+}).
Oxidation-reduction, or redox, reactions are a powerful chemical tool in hazardous waste treatment. These processes involve the transfer of electrons between chemical species, which can change the oxidation state of toxic constituents. A common application is the reduction of highly toxic and soluble hexavalent chromium into the less harmful and more stable trivalent form. By chemically altering the substance, redox reactions can transform hazardous components into safer or more manageable chemical states, making them suitable for subsequent treatment or safe final disposal in a secure environment.

243. (C) Durability and resistance to natural degradation processes.
The high environmental impact of plastic waste stems from its fundamental material properties. Most synthetic plastics are specifically engineered to be extremely durable and resistant to chemical and biological breakdown. Because they are not recognized by natural decomposers like bacteria and fungi, they do not biodegrade. This resistance leads to the long-term persistence and accumulation of plastic debris in ecosystems worldwide. This permanent presence causes ongoing damage to wildlife, contaminates soil and water, and presents a major challenge for waste management systems tasked with their final disposal.

244. (D) Reduce overall transport cost by consolidating waste into larger vehicles.
A transfer station is a key component of an integrated solid waste management system designed to optimize logistics. Its primary purpose is to act as a consolidation point where waste from multiple small collection trucks is reloaded into much larger-capacity vehicles like semi-trailers or rail cars. This process is essential for reducing the total number of trips and overall transportation costs, especially when the final disposal site is far from the city. By increasing transport efficiency, transfer stations ensure that the municipal waste management system remains economically and operationally sustainable.

245. (C) Lead from the CRT glass can leach into the groundwater.
Disposing of e-waste such as old CRT monitors in an unlined landfill creates a direct pathway for toxic contamination. CRT glass contains a high concentration of lead, which is used to shield users from radiation. In a landfill environment, particularly without a protective liner and leachate collection system, this lead can be leached out of the glass over time by rainwater. The resulting toxic liquid can then seep through the soil and contaminate underlying groundwater aquifers, posing a severe and long-term threat to public health and the local environment.

246. (B) Elemental composition (C, H, O, N, S, etc.).
Ultimate analysis is a detailed laboratory procedure used to determine the basic chemical makeup of a solid waste sample. It measures the weight percentages of its constituent elements, primarily carbon, hydrogen, oxygen, nitrogen, and sulfur. This elemental data is essential for calculating the energy content of the waste and

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for predicting the types and amounts of chemical emissions that will be produced during thermal treatment. While proximate analysis identifies physical components like moisture, ultimate analysis provides the fundamental chemical information required for precise engineering and environmental planning.

247. (D) Its pozzolanic nature and fine particle size
From a waste management and resource utilization perspective, the most important characteristics of fly ash are its fine particle size and pozzolanic nature. These properties allow fly ash to react with calcium hydroxide in the presence of water to form stable cementitious compounds. This makes it an exceptionally valuable material for the construction industry, where it is used to enhance the strength and durability of concrete and bricks. By utilizing these unique characteristics, fly ash can be recycled as a high-performance resource instead of being disposed of as a waste.

248. (A) Controlled combustion at high temperatures.
Incineration is a thermal waste treatment technology that involves the controlled burning of solid waste at high temperatures, typically in a specialized furnace. The process is designed to achieve the complete combustion of the organic components of the waste, reducing its total volume and mass significantly. Modern incinerators are equipped with advanced air pollution control systems to manage emissions and often include heat recovery systems to generate electricity or steam. This makes incineration an important part of integrated waste management strategies, especially in urban areas with limited land for landfills.

249. (C) Used batteries and leftover paint
While much of household waste consists of non-hazardous materials like paper and food scraps, it also includes specific items that are classified as hazardous. Used batteries, which may contain heavy metals like lead or cadmium, and leftover paints containing toxic solvents or pigments, are prime examples of hazardous domestic waste. These items pose significant risks to human health and the environment if they are disposed of with regular municipal waste. Recognizing these hazardous components is essential for ensuring they are collected separately and managed through specialized treatment and disposal protocols.

250. (A) Reduction and Reuse
According to the waste management hierarchy, the most sustainable and preferred strategies for managing plastic waste are reduction and reuse. Reduction focuses on preventing waste by using less plastic packaging and choosing products with a lower environmental footprint. Reuse extends the lifespan of plastic items, keeping them out of the waste stream for as long as possible. These proactive approaches address the root cause of plastic pollution more effectively than lower-level strategies like recycling or land filling, which involve higher energy costs and greater risks of environmental contamination.

251. (B) Legislative policies
Solid waste generation rates are influenced by specific environmental and socioeconomic variables. The text explicitly identifies geographic location, economic status, and seasonal changes as key determinants. However, the influence of legislative policies is not addressed within the provided discussion. Understanding these factors is vital for designing effective management systems and predicting waste volume changes in a municipality.

252. (A) To evaluate its potential for recovery and recycling
Analyzing specific materials within the municipal waste stream, such as glass, plastics, and paper, allows managers to assess recovery possibilities. This classification is necessary to identify which items can be diverted from landfills and processed for reuse. By determining these components, planners can implement effective recycling programs and optimize the overall sustainability of the entire waste management system.

253. (C) Evaluating the suitability for combustion and biological treatment
Proximate analysis measures physical characteristics including moisture, volatile matter, fixed carbon, and ash content. These metrics are fundamental for determining if waste can be effectively burned for energy or broken down through biological means. Such data guides the selection of treatment technologies, ensuring

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that the chosen disposal or recovery process is technically feasible and efficient for the waste.

254. (D) Characterizing the waste stream and its generation
Effective waste management planning begins with a thorough understanding of the waste itself. Identifying the sources, types, physical characteristics, and the rate at which waste is produced establishes a foundational knowledge base. This characterization is the bedrock for all later decisions, including collection methods, transportation logistics, and the selection of appropriate recovery or final disposal technologies for the community.

255. (C) Its elemental composition.
Ultimate analysis is a chemical testing method used to identify the specific elements present in a waste sample. It focuses on determining the mass percentage of components such as carbon, hydrogen, nitrogen, oxygen, and sulfur. This detailed elemental breakdown is essential for calculating energy content and predicting potential air pollutants that might be released during any thermal treatment process.

256. (B) Reduced combustion efficiency
Proximate analysis evaluates factors like moisture content to determine the suitability of waste for thermal conversion. Excess water within the waste stream absorbs energy during the heating process, which significantly lowers the overall efficiency of combustion. Understanding this parameter helps engineers decide whether pre-drying is necessary before waste can be effectively used in incineration or gasification systems for energy.

257. (D) The mass percentage of elements like carbon and sulfur
While proximate analysis partitions waste into broad categories like volatile matter and moisture, ultimate analysis provides a deeper chemical profile. It quantifies the specific mass percentages of individual chemical elements. Knowing the exact amounts of carbon, hydrogen, and sulfur is critical for advanced calculations, such as determining precise energy values and designing specialized air pollution control systems for facilities.

258. (A) To predict the formation of air pollutants during combustion
Determining the nitrogen and sulfur content through chemical analysis is vital for environmental protection. During high-temperature combustion, these elements transform into harmful nitrogen oxides and sulfur oxides. Predicting the concentration of these flue gases allows engineers to design appropriate air pollution control technologies. This ensures that waste-to-energy processes remain within regulatory limits and minimize negative environmental impacts.

259. (C) They provide complementary information for evaluating waste treatment options.
Both proximate and ultimate analyses serve distinct but related functions in evaluating solid waste properties. Proximate analysis offers a high-level view of physical combustion characteristics, while ultimate analysis provides a detailed chemical and elemental breakdown. Together, these methods offer a complete profile that is essential for making informed decisions regarding energy recovery, technology selection, and strict environmental compliance measures.

260. (A) Ultimate analysis
To accurately determine the energy potential of solid waste, a detailed understanding of its chemical elements is required. Ultimate analysis identifies the mass percentages of carbon and hydrogen, which are the primary contributors to energy release. These elemental data points are necessary for calculating the precise calorific value, which informs the feasibility and design of waste-to-energy plant operations.

261. (D) A large construction and demolition project
Hauled container systems are designed for locations where waste accumulates in massive quantities. Construction and demolition sites produce bulky, heavy debris that requires large-scale roll-off containers. In this system, the entire container is picked up and transported to a disposal site. This approach is more efficient for managing high-volume sources than using smaller, fixed bins or household carts.

262. (B) The movement of the storage container during collection

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The primary distinction between the two collection systems lies in whether the container remains at the site or is moved. In one method, the storage unit is physically taken to the processing facility. In the other method, a truck empties the container's contents into a hopper and leaves the unit behind. This fundamental difference determines the specialized equipment used.

263. (C) Reduce operational costs, fuel use, and time.
Waste collection is a resource-intensive process that accounts for a large portion of management budgets. By carefully planning the paths taken by collection vehicles, municipalities can minimize the distance traveled. This optimization directly leads to lower fuel expenses, reduced labor hours, and faster service. Efficient routing also lessens the environmental footprint by decreasing vehicle emissions and reducing urban traffic.

264. (D) Waste is collected from numerous, relatively small-volume sources.
Residential waste management involves gathering materials from a high density of homes, each producing relatively small amounts of garbage. Using stationary bins or carts allows a single truck to service many customers in a single trip. This method is highly efficient for frequent, small-scale pickups, avoiding the high cost and logistical complexity of moving individual containers from every home.

265. (A) The day of the week for collection
The passage outlines several physical and logistical factors that influence the design of waste collection routes. It specifically mentions the impact of traffic patterns, the presence of one-way streets, and the physical placement of containers. However, the text does not discuss the scheduling of service or the specific days of the week when collection occurs for the local residents.

266. (B) It reduces overall transportation costs through waste consolidation.
Transfer stations serve as intermediate points where waste from several small collection trucks is combined. By consolidating this material into much larger transport vehicles like semi-trailers, the total number of trips to distant disposal sites is reduced. This leverage of economies of scale significantly lowers fuel consumption and labor costs, making the entire long-distance transportation network more financially sustainable.

267. (B) Decreasing the number of vehicle trips to the disposal site
Consolidating waste at a central facility allows for more efficient long-haul transport. By using larger vehicles, the management system requires fewer individual trips to regional landfills or recovery centers. This reduction in vehicle traffic leads to lower fossil fuel usage and decreased emissions of air pollutants. Additionally, it helps alleviate traffic congestion on major roadways leading to disposal facilities.

268. (A) Preliminary screening and removal of certain items
Beyond serving as a logistics hub, transfer stations often facilitate initial waste processing. Operations may include sorting through the incoming material to remove bulky items that could damage transport equipment. Additionally, these facilities can serve as recovery points where recyclable materials are diverted before the remaining waste is sent to its final destination, enhancing the overall efficiency of recovery.

269. (C) The efficiency of a waste management system can be improved by optimizing transportation logistics.
The text demonstrates that managing waste is not just about collection and disposal, but also about the logistical links between them. By strategically integrating transfer stations, planners can address the economic and environmental challenges of hauling waste over long distances. Optimizing these transportation networks through consolidation and preliminary screening significantly improves the overall functional efficiency of a modern system.

270. (D) An intermediate hub for waste consolidation and transfer.
A transfer station functions as a vital link in the waste management chain, connecting local collection points with remote disposal facilities. It acts as a temporary consolidation hub where materials from various sources are gathered and reloaded onto larger vehicles. This intermediate step is essential for streamlining logistics,

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reducing transportation costs, and improving the environmental performance of the infrastructure.

271. (C) To transform waste into a usable resource
The shift toward a circular economy focuses on redefining the value of discarded materials. Instead of viewing waste as something to be buried, processing and recovery techniques aim to extract useful elements for new purposes. By reclaiming materials like glass, metal, and paper, these operations ensure that waste is redirected back into the economy, serving as a raw resource.

272. (B) Uses processed waste itself as a primary raw material.
While traditional recycling involves processing materials to create new versions of the same product, direct manufacture uses the waste stream more fundamentally. In this process, the waste itself acts as the primary raw material for creating distinct items, such as furniture or construction components. This approach provides a direct pathway for repurposing significant volumes of waste into functional and durable goods.

273. (D) The purity of the sorted materials
For recovered materials to be integrated back into manufacturing, they must meet specific quality standards. The level of contamination or the purity of the sorted waste stream determines whether it can be used in production processes. Ensuring high purity requires efficient sorting and source separation systems. Without clean material streams, the economic and technical viability of recycling and recovery is compromised.

274. (A) The reduction in demand for virgin raw materials.
Reclaiming materials from the waste stream has a profound impact on resource conservation. By supplying manufacturers with recycled inputs, the need to extract new, virgin materials from the earth is significantly diminished. This conservation effort saves energy, protects natural ecosystems from mining and logging, and reduces the environmental footprint associated with the production of new consumer goods.

275. (C) Reintegrating recovered materials back into the production cycle.
Closing the loop is a fundamental concept where materials follow a circular path rather than a linear one ending in disposal. It involves collecting waste, processing it into high-quality resources, and then using those resources to manufacture new products. This cycle ensures that materials are continuously repurposed within the economy, minimizing the need for new inputs and eliminating waste.

276. (A) To create a uniform, energy-rich fuel for electricity generation
Transforming raw waste into pellets or Refuse Derived Fuel is done to improve its performance as a fuel source. Raw waste is often inconsistent in size and energy value. Processing creates a standardized product with reliable combustion properties. These fuels are easier to handle and store, making them ideal for generating electricity in both specialized facilities and existing power plants.

277. (D) RDF involves more extensive processing to achieve higher quality.
Refuse Derived Fuel is distinguished by the level of refinement it undergoes compared to simpler waste-derived products. The production process involves thorough sorting to remove non-combustible items and shredding to achieve a uniform size. This extensive processing results in a higher calorific value and lower ash content. Consequently, RDF is a more efficient and cleaner-burning fuel than minimally processed waste.

278. (B) Diverting waste from landfills and recovering its energy value
Waste-to-energy strategies address two environmental challenges simultaneously. First, they provide a way to manage large volumes of municipal waste without relying on landfills, which saves space and prevents soil contamination. Second, they capture the chemical energy stored within combustible materials to produce power. This turns a disposal problem into a sustainable source of electricity, contributing to overall energy security.

279. (C) It consists of the combustible fraction of processed waste.
Fuel pellets and Refuse Derived Fuel are not made from the entire, unsorted waste stream. Instead, they are produced by isolating the combustible components, such as paper and certain plastics.

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By removing non-burnable materials like glass and metal, the resulting fuel becomes much more efficient. This targeted use of the combustible fraction ensures a high energy output during generation.

280. (D) Burning waste-derived fuels alongside conventional fuels in a power plant.
Co-firing is a combustion practice where different types of fuels are burned at the same time in the same boiler. In the context of waste management, this typically means using waste-derived fuels, such as RDF, alongside traditional fossil fuels like coal. This technique allows existing energy infrastructure to reduce its reliance on non-renewable resources while effectively disposing of processed waste.

281. (A) Composting is an aerobic process, while biomethanation is anaerobic.
The fundamental difference between these two biological treatments is the environment in which decomposition occurs. Composting relies on aerobic microorganisms that require oxygen to break down organic matter into a stable soil conditioner. In contrast, biomethanation is an anaerobic process that happens in an oxygen-free environment. This lack of oxygen allows specific bacteria to produce methane-rich biogas as a byproduct.

282. (B) A gas mixture called biogas, rich in methane.
Biomethanation is specifically designed to capture the gases released during the anaerobic breakdown of organic waste. The primary output is biogas, which is a mixture consisting mostly of methane and carbon dioxide. This gas is a valuable renewable energy source that can be used for heating or electricity. Capturing this methane also prevents it from entering the atmosphere.

283. (B) Employs earthworms to produce a high-quality fertilizer.
Vermicomposting is a specialized biological treatment that uses earthworms to speed up the decomposition of organic materials. The worms consume the waste and transform it into vermicast, a nutrient-rich fertilizer. This process is often praised for its efficiency in small-scale settings and its ability to produce a superior product for soil enrichment compared to traditional aerobic composting methods.

284. (A) Can be used as soil conditioners or renewable energy sources.
The outputs of biological waste treatments provide significant utility. Compost and digestate are used to improve soil quality by adding essential nutrients and organic matter, supporting sustainable agriculture. Biogas serves as a versatile renewable fuel for producing heat and power. These products represent a successful conversion of organic waste into assets that support environmental sustainability and the circular economy.

285. (C) The diversion of organic waste from landfills.
One of the most significant environmental advantages of biological treatments is preventing organic matter from entering landfills. When organics decompose in landfills, they often produce harmful leachate and uncontrolled greenhouse gases. By processing this waste through composting or biomethanation, municipalities reduce the burden on landfill capacity and decrease the overall environmental impact associated with disposal of biodegradable materials.

286. (D) It is an engineered facility with environmental controls like liners.
Unlike a basic dump, a sanitary landfill is a sophisticated engineering project designed to protect the surrounding ecosystem. It incorporates specialized features such as bottom liners to prevent groundwater contamination and gas collection systems to manage methane. These environmental controls, combined with systematic operational procedures, ensure that the waste is safely isolated from the air, soil, and water.

287. (C) Control vectors, fires, odors, and litter.
Managing a landfill requires daily actions to minimize its impact on the local community and environment. Applying a layer of soil or alternative cover at the end of each day prevents pests from accessing the waste. This practice also helps contain unpleasant smells, reduces the risk of surface fires, and keeps lightweight debris from being scattered by the wind.

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heat released during complete combustion and is classified as a chemical characteristic of the waste. It is typically determined through laboratory testing using a bomb calorimeter. Knowledge of the energy content is essential for designing and operating efficient waste-to-energy facilities like incinerators, as it directly influences the amount of steam and electricity that can be generated from the waste stream.

228. (D) Production of methane gas from organic material under anaerobic conditions.
Biomethanation is a biological process that occurs in an environment devoid of oxygen, where anaerobic microorganisms break down biodegradable organic waste. This digestion process results in the production of biogas, which is primarily a mixture of methane and carbon dioxide. This technology provides a dual benefit by treating organic waste and generating a renewable source of energy. The captured methane can be used for heating or electricity production, while the solid residue can serve as an organic fertilizer, making biomethanation a key part of sustainable waste management.

229. (C) In the manufacturing of bricks and cement
Fly ash is a fine powdery residue from coal combustion that is widely utilized as an industrial by product in the construction industry. Its physical and chemical properties, including its high silica content and pozzolanic activity, make it a valuable raw material for manufacturing high-quality bricks and cement. By incorporating fly ash into these materials, manufacturers can improve structural durability while reducing the consumption of natural resources and energy. This practice diverts large volumes of fly ash from landfills, demonstrating a successful model for industrial recycling and sustainable infrastructure development.

230. (D) Clogging drains and sewer systems, leading to flooding.
The improper disposal of plastic bags poses a significant challenge for urban infrastructure in many cities. Because they are lightweight and durable, plastic bags are easily carried by wind or water into drainage and sewer systems. Once there, they accumulate and create blockages that prevent the free flow of water. This is a major cause of localized flooding during heavy rains, which can lead to property damage and public health hazards. These infrastructural issues highlight the need for effective plastic waste management and the reduction of single-use plastic consumption.

231. (D) Stabilization
Stabilization is a chemical treatment technology used in hazardous waste management to reduce the toxicity and mobility of hazardous constituents. This process involves adding specific chemical reagents to the waste to induce reactions that convert toxic elements into more stable, less soluble, or less hazardous forms. This chemical transformation is often followed by physical solidification. Together, these steps ensure that the hazardous components are safely contained and immobilized, preventing them from leaching into the environment when the treated residues are eventually disposed of in a secure hazardous waste landfill.

232. (A) Both Statement I and Statement II are true.
The choice between different waste collection systems depends on the characteristics of the generation site. A Hauled Container System is most efficient for locations that generate large volumes of waste, such as construction sites, because transporting the entire container is justified by the large quantity of material. Conversely, a Stationary Container System is more efficient in residential areas with multiple small sources, as it allows a single vehicle to empty many bins in one trip. Therefore, both statements correctly identify the operational conditions under which each collection system is most effective.

233. (C) Primary agent of decomposition (microorganisms vs. earthworms plus microorganisms).
The primary difference between traditional composting and vermicomposting is the biological agent responsible for decomposition. While traditional composting relies exclusively on diverse populations of microorganisms like bacteria and fungi to break down organic matter, vermicomposting utilizes specific species of earthworms in combination with these microorganisms. The worms physically break down the waste, accelerating the process and producing a distinct end product called vermicast.

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297. (A) A mixture of both valuable and hazardous substances.
Electronic waste presents a unique management challenge because it is composed of highly diverse materials. It contains valuable resources like gold and copper that are economically beneficial to recover. Simultaneously, it houses toxic elements such as lead and mercury. This combination requires specialized dismantling and processing techniques to safely extract the useful components without releasing harmful pollutants into the environment.

298. (B) Its utilization in manufacturing and construction.
Rather than simply disposing of fly ash in landfills, modern strategies emphasize its reuse in industrial applications. Its chemical properties make it an excellent additive for manufacturing cement, concrete, and bricks. It is also used effectively for soil stabilization in engineering projects. This approach turns a potential environmental liability into a valuable raw material for the construction and manufacturing sectors.

299. (B) Its persistence and potential harm to wildlife
Plastic waste is particularly problematic because it does not biodegrade easily and remains in the environment for centuries. Over time, large plastic items fragment into tiny microplastics, which can enter the food chain. This persistence poses a significant threat to various species and entire ecosystems. Managing this ubiquity is difficult, as the material's durability leads to widespread long-lasting pollution.

300. (A) Each waste requires a specific management strategy based on its unique properties and impacts.
Effective management of diverse materials like e-waste, fly ash, and plastics requires tailored solutions. There is no single method that applies to all types of special waste. Instead, strategies must be developed based on the specific chemical and physical properties of each material. This targeted approach ensures that resources are recovered efficiently while the distinct environmental risks are mitigated.

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CHAPTER 08

Environmental Assessment, Management and Legislation

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1. What is the primary aim of Environmental Impact Assessment (EIA)?
(A) To maximize project profits while minimizing environmental compliance costs and long-term regulatory overheads.
(B) To predict impacts early in planning, identify reduction methods, and adapt projects to the local environment.
(C) To ensure developmental projects are designed and executed without any environmental considerations or public scrutiny.
(D) To focus on social and cultural impacts while largely ignoring ecological, geological, and biological aspects.

2. Consider the following statements:
Statement I : An Environmental Impact Statement (EIS) is the final decision-making document used by the government.
Statement II : An Environmental Management Plan (EMP) outlines the mitigation, monitoring, and institutional measures to be taken during and after a project.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

3. Which of the following is NOT a typical step in the Risk Assessment process?
(A) Hazard identification
(B) Scenarios of exposure
(C) Risk mitigation funding
(D) Risk characterization

4. A company plans to build a new factory. Before construction, they conduct a study to evaluate the potential effects on the local air, water, and wildlife, and propose measures to minimize harm. This entire process is best described as:
(A) Environmental Audit
(B) Cost-Benefit Analysis
(C) Life-Cycle Analysis
(D) Environmental Impact Assessment

5. Which part of the Indian Constitution directs the State to protect and improve the environment and to safeguard the forests and wildlife of the country?
(A) Article 51A(g)
(B) Article 21
(C) Article 48A
(D) Article 19

6. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The ISO 14000 series of standards are primarily concerned with product quality and safety.
Reason (R) : These standards provide a framework for a strategic approach to an organization's environmental policy, plans, and actions.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

7. The Precautionary Principle is a key component of which national policy?
(A) National Forest Policy, 1988
(B) National Water Policy, 2002
(C) National Health Policy, 2017
(D) National Environmental Policy, 2006

8. Which of the following statements about the Montreal Protocol is incorrect?
(A) It primarily addresses the issue of global

warming and carbon emissions.
(B) It was signed in 1987.
(C) It is an international treaty designed to protect the ozone layer.
(D) It phases out the production and consumption of ozone-depleting substances.

9. Consider the following statements regarding an Environmental Management Plan (EMP):
1. It is prepared as part of the EIA report.
2. It details the measures for mitigation of adverse environmental impacts.
3. It includes a plan for monitoring environmental quality during project operation.
4. It is a one-time plan implemented only before project construction begins.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 4 only
(B) 1, 2 and 3 only
(C) 2, 3 and 4 only
(D) 1 and 4 only

10. The term 'Life-cycle analysis' (LCA) in environmental assessment refers to:
(A) Evaluating environmental impacts of a product, process, or service from cradle to grave.
(B) Analyzing the expected lifespan of specific endangered species in a given project area.
(C) Assessing a project's economic viability and financial returns over its entire duration.
(D) Studying the biological life cycle stages of a specific organism within its habitat.

11. What is the main objective of the Basel Convention (1989, 1992)?
(A) To conserve wetlands of international importance.
(B) To phase out the use of ozone-depleting substances.
(C) To combat desertification and mitigate the effects of drought.
(D) To control the transboundary movements of hazardous wastes and their disposal.

12. Match List-I (Environmental Act) with List-II (Year of Enactment).
List I: (Environmental Act)
P. The Water (Prevention and Control of Pollution) Act
Q. The Air (Prevention and Control of Pollution) Act
R. The Environmental (Protection) Act
S. The Wildlife Protection Act
List II: (Year of Enactment)
1. 1986
2. 197$_2$
3. 1974
4. 1981
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

13. The Rio Summit of 199$_2$ led to the establishment of which of the following?
(A) United Nations Environment Programme (UNEP)
(B) Intergovernmental Panel on Climate Change (IPCC)
(C) Convention on Biological Diversity (CBD)
(D) Montreal Protocol

14. Identifying the potential sources of harm or adverse health effects is a step in risk assessment known as:
(A) Risk Characterization
(B) Exposure Assessment
(C) Risk Management
(D) Hazard Identification

15. Arrange the following international environmental events in chronological order:
1. Stockholm Conference on Human Environment
2. Earth Summit at Rio de Janeiro
3. Earth Summit at Johannesburg
4. Copenhagen Summit
(A) 1, 2, 3, 4
(B) 2, 1, 4, 3
(C) 1, 3, 2, 4
(D) 4, 3, 2, 1

16. The EIA Notification, $_2$006 in India categorizes developmental projects into how many categories for the purpose of prior environmental clearance?
(A) One category, requiring central clearance.
(B) Two categories (A and B), based on the potential impacts.
(C) Three categories (I, II, and III), based on

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project cost.
(D) Four categories, based on geographical location.

17. The concept of 'Eco-labeling schemes' is primarily intended to:
(A) Generate revenue for the government through environmental taxes.
(B) Help consumers identify environmentally friendly products.
(C) Mandate specific manufacturing processes for all industries.
(D) Provide subsidies to polluting industries.

18. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Forest Conservation Act, 1980 was enacted to check indiscriminate deforestation and diversion of forest land for non-forest purposes.
Reason (R) : The Act requires prior approval of the Central Government for de-reservation of reserved forests or use of forest land for any non-forest purpose.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

19. Which of the following is NOT covered under the The Bio-Medical Waste Management Rules, 2016?
(A) Waste from hospitals and nursing homes
(B) Waste from veterinary institutions
(C) Radioactive wastes
(D) Waste from vaccination camps

20. What is the fundamental duty of every citizen of India regarding the environment, as enshrined in Article 51A(g) of the Constitution?
(A) To commercially exploit natural resources for rapid economic growth and industrial expansion.
(B) To develop heavy industries regardless of their negative environmental impact or resource depletion.
(C) To file litigation against all development projects to ensure total preservation of natural land.
(D) To protect and improve the natural environment and to have compassion for all living creatures.

21. Consider the following statements regarding the Kyoto Protocol:
1. It is an international treaty that extends the 1992 UNFCCC.
2. It commits state parties to reduce greenhouse gas emissions.
3. It was adopted in Kyoto, Japan, in 1997.
4. The United States was the first country to ratify the protocol.
5. It applies equally to both developed and developing nations with the same emission reduction targets.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3 only
(B) 1, 2, 3, 4 and 5
(C) 2, 4 and 5 only
(D) 1, 3 and 4 only

22. A systematic, documented, periodic, and objective evaluation of how well an organization's management system is performing with respect to environmental regulations is known as:
(A) Life-Cycle Analysis
(B) Environmental Audit
(C) Risk Assessment
(D) Cost-Benefit Analysis

23. The Clean Development Mechanism (CDM), a provision under the Kyoto Protocol, allows:
(A) Developed countries to invest in emission-reduction projects in other developed countries.
(B) Developing countries to set their own emission caps and trade them on global markets.
(C) All countries to freely trade emission permits without any institutional or legal restrictions.
(D) Developed countries to invest in emission-reduction projects in developing nations.

24. The Water (Prevention and Control of Pollution) Act was enacted in which year?
(A) 1974
(B) 1981
(C) 1986

NODIA

(D) 1972

25. RIO+20, the United Nations Conference on Sustainable Development, was held in 2012 in:
(A) Johannesburg, South Africa
(B) Copenhagen, Denmark
(C) Rio de Janeiro, Brazil
(D) Stockholm, Sweden

26. Which of the following waste management rules was NOT notified in the year 2016?
(A) The Batteries (Management and Handling) Rules
(B) The Plastic Waste Management Rules
(C) The e-waste (Management) Rules
(D) The Solid Waste Management Rules

27. Match List-I (Convention/Protocol) with List-II (Primary Focus).
List I: (Convention/Protocol)
P. Ramsar Convention
Q. Montreal Protocol
R. Basel Convention
S. Kyoto Protocol
List II: (Primary Focus)
1. Transboundary movement of hazardous waste
2. Climate change and greenhouse gas emissions
3. Protection of the ozone layer
4. Conservation of wetlands
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-1, S-2
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-1, S-4

28. In the context of Risk Assessment, 'Risk Characterization' involves:
(A) Identifying all potential hazards in a workplace.
(B) Estimating the incidence and severity of adverse effects likely to occur in a population due to exposure.
(C) Determining the pathways through which populations are exposed to a hazard.
(D) Implementing measures to control and mitigate the identified risks.

29. Consider the following statements:
Statement I : Cost-benefit analysis in the context of EIA quantifies the environmental costs and benefits of a project in monetary terms.
Statement II : All environmental impacts, such as loss of biodiversity and aesthetic value, can be easily and accurately quantified in monetary terms.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

30. The term Hazard Accounting in risk assessment primarily refers to:
(A) Calculating the financial cost of a potential disaster or a hazardous material spill.
(B) Keeping a formal record of past industrial accidents and their underlying environmental causes.
(C) Assigning legal accountability for the cleanup of hazardous material spills at a site.
(D) Identifying and cataloging types and quantities of hazardous materials at a facility.

31. Consider the following statements regarding the Wildlife Protection Act, 1972:
1. It provides for the protection of wild animals, birds, and plants.
2. It prohibits hunting of any wild animal specified in Schedules I, II, III, and IV.
3. The Act was last amended in 1991.
4. It led to the establishment of National Parks and Wildlife Sanctuaries.
Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 1, 2, 3 and 4
(C) 3 and 4 only
(D) 1, 2 and 4 only

32. The Global Environmental Facility (GEF) serves as a financial mechanism for which of the following conventions?
(A) Only the Convention on Biological Diversity (CBD)
(B) Both CBD and UNFCCC, among others.
(C) Only the United Nations Framework Convention on Climate Change (UNFCCC)
(D) Only the Ramsar Convention on Wetlands

33. Which one of the following is NOT an objective of the National Environmental Policy, 2006?

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(A) Conservation of critical environmental resources.
(B) Ensuring all developmental projects are exempted from formal environmental scrutiny.
(C) Livelihood security for the poor, particularly resource-dependent communities.
(D) Integration of environmental concerns into policies, plans, programs, and projects.

34. The Public Liability Insurance Act, 1991 was enacted to provide:
(A) Immediate relief to persons affected by accidents while handling hazardous substances.
(B) Insurance cover for all public sector employees.
(C) Health insurance for people living below the poverty line.
(D) Life insurance for individuals working in hazardous industries.

35. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Air (Prevention and Control of Pollution) Act, 1981 was amended in 1987.
Reason (R) : The amendment included noise as an air pollutant.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

36. The UN Summit on Millennium Development Goals (MDGs) was held in the year:
(A) 1992
(B) 2002
(C) 2009
(D) 2000

37. The procedure for reviewing the EIA of developmental projects typically involves a step for public consultation. What is the primary purpose of this step?
(A) To inform the public about a final decision that has already been officially made.
(B) To get the public's formal approval for the project, which is binding on authorities.
(C) To identify concerns of affected persons and incorporate them into the project design.
(D) To fulfill a legal formality without any actual impact on the final decision-making.

38. Arrange the following Acts in the order of their enactment, from earliest to latest:
1. Environmental (Protection) Act
2. Air (Prevention and Control of Pollution) Act
3. Water (Prevention and Control of Pollution) Act
4. Biological Diversity Act
(A) 3, 2, 1, 4
(B) 2, 3, 1, 4
(C) 3, 1, 2, 4
(D) 1, 2, 3, 4

39. The main aim of the Indian Forest Act, Revised 198_2, is primarily related to:
(A) The conservation of forest biodiversity.
(B) Providing forest-dwelling communities with ownership rights.
(C) Promoting afforestation on non-forest land.
(D) Regulating the transit of forest produce and levying duties on timber.

NODIA

40. Which of the following international bodies is primarily responsible for assessing the science related to climate change?
(A) Intergovernmental Panel on Climate Change (IPCC)
(B) United Nations Environment Programme (UNEP)
(C) International Geosphere-Biosphere Programme (IGBP)
(D) Global Environmental Facility (GEF)

41. Consider the following statements regarding the Coastal Regulation Zone (CRZ) Notification, 1991:
1. It aims to protect coastal ecosystems and communities.
2. It classifies the coastal zone into different categories for regulation.
3. It prohibits all developmental activities in the entire coastal zone.
4. It has never been amended since its original notification.
5. Its regulations apply uniformly to all coastal

states without any local variation.

Which of the above statement(s) is/are correct?

(A) 1 and 2 only
(B) 1, 2, 3, 4 and 5
(C) 3, 4 and 5 only
(D) 1, 3 and 4 only

42. A factory manager is preparing a document that outlines the step-by-step procedures to minimize pollution, handle wastes, and respond to emergencies, along with a schedule for monitoring air and water quality. This document is best described as:

(A) Environmental Management Plan (EMP)
(B) Environmental Impact Statement (EIS)
(C) Risk Characterization Report
(D) Life-Cycle Analysis (LCA)

43. The Stockholm Conference on Human Environment held in 1972 is significant because:

(A) It resulted in the signing of the Kyoto Protocol to combat global warming and greenhouse gases.
(B) It was where the Basel Convention on hazardous waste and its transboundary movement was adopted.
(C) It exclusively focused on the conservation of wetlands and migratory waterbird habitats worldwide.
(D) It was the first major international environmental conference and led to the creation of UNEP.

44. Match List-I (Type of Waste) with List-II (Relevant Rules, 2016).

List I: (Type of Waste)

P. Waste from households and street sweeping
Q. Discarded electrical and electronic equipment
R. Waste from hospitals and clinics
S. Leftover materials from building projects

List II: (Relevant Rules, 2016)

1. The Bio-Medical Waste Management Rules
2. The Construction and Demolition Waste Management Rules
3. The Solid Waste Management Rules
4. The e-waste (Management) Rules

(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-1, S-2

NODIA

45. The Biological Diversity Act, 2002 was enacted in India primarily to:

(A) Regulate the import of exotic species.
(B) Promote genetically modified organisms.
(C) Implement the obligations of the Convention on Biological Diversity (CBD).
(D) Establish a national network of zoos and botanical gardens.

46. Which of the following is an example of an 'Impact Assessment Methodology'?

(A) Public Consultation
(B) Cost-Benefit Analysis
(C) Environmental Auditing
(D) Checklists and Matrices

47. The Motor Vehicle Act, 1988, contains provisions related to environmental protection by:

(A) Setting standards for vehicular emissions and noise.
(B) Regulating traffic signals in urban areas.
(C) Mandating the use of public transport.
(D) Controlling the price of fuel.

48. Consider the following statements:

Statement I : Environmental Planning should be seen as a separate activity, conducted after the EIA and Environmental Audit are completed.

Statement II : Environmental Planning is an integral part of EIA and Environmental Audit, guiding the overall strategy for sustainable development.

(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

49. 'Hazard Scenarios of Exposure' in a risk assessment study would most likely involve:

(A) Estimating the number of people who will be harmed.
(B) Describing the pathways by which individuals or the environment might come into contact with a hazard.
(C) Identifying the chemical properties of a hazardous substance.
(D) Listing all past incidents involving the hazard.

50. The National Forest Policy, 1988, has a major objective of:

(A) Meeting the basic needs of rural and tribal populations for fuel, fodder, and forest produce.
(B) Ensuring that at least 50% of the country's geographical area is placed under forest cover.
(C) Promoting the conversion of forest land for industrial use and heavy manufacturing projects.
(D) Maximizing annual revenue from timber extraction for the various state government bodies.

51. Consider the following statements about ISO 14000 series:
1. It is a series of voluntary standards for environmental management.
2. Certification to ISO 14001 is mandatory for all industries in India.
3. The standards focus on what an organization does to minimize its harmful effects on the environment.
4. They are primarily product standards, not management system standards.

Which of the above statement(s) is/are correct?
(A) 1 and 3 only
(B) 2 and 4 only
(C) 1, 2 and 3 only
(D) 1, 3 and 4 only

52. The term Agenda 21, adopted at the Earth Summit in Rio de Janeiro (1992), refers to:
(A) A list of 21 endangered species requiring immediate protection.
(B) A treaty to reduce greenhouse gas emissions by 21%.
(C) The 21 founding principles of the United Nations Environment Programme.
(D) A comprehensive plan of action for global sustainable development.

53. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Environmental (Protection) Act, 1986 is an 'umbrella' legislation.
Reason (R) : It provides a framework for the central government to coordinate the activities of various central and state authorities established under previous laws like the Water Act and Air Act.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

54. The Noise Pollution (Regulation and Control) Rules, $_2$000, specify ambient noise standards for different areas. Which of the following is NOT one of the standard area classifications?
(A) Industrial Area
(B) Agricultural Area
(C) Commercial Area
(D) Residential Area

55. The Ramsar Convention on Wetlands was signed in 1971 in which country?
(A) Switzerland
(B) India
(C) Australia
(D) Iran

56. Consider the following Waste Management Rules and arrange them in chronological order based on their notification in 2016:
1. The Solid Waste Management Rules
2. The e-waste (Management) Rules
3. The Bio-Medical Waste Management Rules
4. The Plastic Waste Management Rules

Which of the above statement(s) is/are correct?
(A) 4, 3, 2, 1
(B) 1, 2, 3, 4
(C) 2, 4, 1, 3
(D) A precise chronological order cannot be determined as all were notified in the same year.

57. The National Water Policy, 2002 emphasizes:
(A) The privatization of all water resources.
(B) The unlimited exploitation of groundwater for agricultural purposes.
(C) A shift from a purely engineering-centric approach to a more holistic and river basin-oriented approach.
(D) The exclusive use of surface water, banning the use of groundwater.

58. The final step in the Risk Assessment process, which involves making decisions about which

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risks need management and implementing strategies to control them, is called:
(A) Risk Management
(B) Hazard Identification
(C) Risk Characterization
(D) Exposure Assessment

59. Match List-I (Legal Provision) with List-II (Act/Constitution).
List I: (Legal Provision)
P. Inclusion of 'Noise' as an air pollutant
Q. Prior Central Govt. approval for de-reservation of forests
R. Fundamental duty to protect the environment
S. Rules for management of hazardous waste
List II: (Act/Constitution)
1. Forest Conservation Act, 1980
2. Environmental (Protection) Act, 1986
3. Constitution of India (Article 51A)
4. Air (Prevention and Control of Pollution) Act, 1981 (as amended)
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-2, R-3, S-1
(D) P-3, Q-1, R-4, S-2

60. The Copenhagen Summit of 2009 is primarily associated with discussions on:
(A) Protecting biodiversity
(B) Climate change mitigation and adaptation
(C) Combating desertification
(D) Regulating transboundary waste movement

61. The purpose of The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000 is to:
(A) Ban the import of all chemicals into India.
(B) Promote the use of hazardous chemicals in agriculture.
(C) Regulate the activities related to certain hazardous chemicals to prevent major accidents.
(D) Set standards for chemical content in food products.

62. Which one of the following is a key feature of the Biological Diversity Act, 2002?
(A) It encourages the patenting of indigenous knowledge by foreign corporations.
(B) It centralizes all decision-making regarding biological resources with the Central Government.
(C) It replaces the Forest Conservation Act and the Wildlife Protection Act.
(D) It provides for equitable sharing of benefits arising from the use of biological resources and associated traditional knowledge.

63. Consider the following statements regarding the EIA process:
1. Screening: Determines if EIA is required.
2. Scoping: Identifies the key impacts to be studied.
3. Impact Analysis: Predicts the nature and magnitude of impacts.
4. Mitigation: Recommends measures to reduce negative impacts.
5. Reporting: Presents the results in an EIS.
Which of the above statement(s) is/are correct?
(A) 1, 2, 3, 4 and 5 are all correct and in the right order.
(B) 2, 1, 3, 5, 4 is the correct sequence.
(C) Only 1, 3 and 5 are part of the formal EIA process.
(D) 1, 2, 4, 3, 5 is the correct sequence.

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64. The Batteries (Management and Handling) Rules, 2010 (with amendments) place the primary responsibility for the collection and recycling of used batteries on the:
(A) Consumer
(B) Producer/Importer
(C) Municipal Corporation
(D) State Pollution Control Board

65. Which of the following statements about the Environmental (Protection) Act, 1986 is incorrect?
(A) It was enacted in the wake of the Bhopal Gas Tragedy.
(B) It is only applicable to air and water pollution.
(C) It gives wide-ranging powers to the Central Government to protect the environment.
(D) It allows the government to set standards for environmental quality and emissions.

66. A process to systematically evaluate the environmental consequences of a proposed policy, plan or programme is the definition of:
(A) Strategic Environmental Assessment

(B) Project-specific Environmental Impact Assessment
(C) Environmental Audit
(D) Risk Assessment

67. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Life-Cycle Analysis (LCA) is often complex and data-intensive.
Reason (R) : LCA must account for all inputs and outputs, including raw material extraction, manufacturing, transportation, use, and disposal.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

68. The primary purpose of the amendment of 1991 to the Wildlife Protection Act, 197_2 was to:
(A) Introduce new schedules for rare plants.
(B) Weaken the penalties for poaching.
(C) Allow for commercial hunting in certain areas.
(D) Provide for the protection of specified plants and to regulate trade in them.

69. Which international organization is a global environmental authority that sets the global environmental agenda and promotes the coherent implementation of the environmental dimension of sustainable development within the UN system?
(A) IPCC
(B) IGBP
(C) UNEP
(D) GEF

70. Which of the following is the best description of Risk Management?
(A) The scientific process of identifying hazards and characterizing their potential for harm.
(B) The process of analyzing, evaluating, and making decisions to control and reduce identified risks.
(C) The documentation of all potential risks in a risk register.
(D) The calculation of the probability of an adverse event occurring.

71. Consider the following:
1. The Plastic Waste Management Rules, 2016
2. The Bio-Medical Waste Management Rules, 2016
3. The Solid Waste Management Rules, 2016
4. The e-waste (Management) Rules 2016

Which of the above statement(s) is/are correct regarding the principle of 'Extended Producer Responsibility' (EPR)?
(A) 1 and 4 only
(B) 2 and 3 only
(C) 1, 2, 3 and 4
(D) 1, 3 and 4 only

72. The Forest Conservation Act of 1980 is primarily concerned with:
(A) Conservation of forest land and preventing its diversion for non-forest purposes.
(B) Increasing the forest cover of the country.
(C) Regulating the timber trade within states.
(D) Establishing new biosphere reserves.

73. The term IGBP stands for:
(A) Intergovernmental Body for Policy on a Green Planet
(B) Indian Green Building Programme
(C) International Geosphere-Biosphere Programme
(D) International Guideline for Biosafety Protocols

74. Arrange the following international agreements/events in the correct chronological sequence of their adoption/occurrence:
1. Montreal Protocol
2. Basel Convention
3. Kyoto Protocol
4. Earth Summit at Rio de Janeiro

(A) 1, 4, 2, 3
(B) 1, 2, 4, 3
(C) 2, 1, 4, 3
(D) 4, 1, 2, 3

75. According to the Solid Waste Management Rules, $_2$016, waste segregation at the source is the responsibility of the:
(A) Waste collector
(B) Municipal authority
(C) Recycling facility

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(D) Waste generator

76. The Conference of Parties (COPs) is the supreme decision-making body of which convention?
(A) Ramsar Convention
(B) United Nations Framework Convention on Climate Change (UNFCCC)
(C) Basel Convention
(D) Stockholm Convention on POPs

77. Match List-I (Policy/Rule) with List-II (Year).
List I: (Policy/Rule)
P. National Environmental Policy
Q. The Solid Waste Management Rules
R. National Forest Policy
S. The Bio-Medical Waste Management Rules
List II: (Year)
1. 1988
2. 2016
3. 2006
4. 2016
(A) P-3, Q-2, R-1, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-3, S-4

78. The e-waste (Management) Rules, 2016 apply to:
(A) Only manufacturers of specific electrical and electronic equipment.
(B) Only consumers of electronic goods and telecommunication hardware.
(C) Only government departments and regulated administrative agencies.
(D) Every entity involved in electronic equipment manufacturing and sales.

79. Consider the following statements:
Statement I : An Environmental Impact Statement (EIS) is the document prepared to describe the positive and negative environmental effects of a proposed action.
Statement II : A Cost-Benefit Analysis is a methodology used within an EIS to evaluate the monetary value of impacts.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

80. The Construction and Demolition Waste Management Rules, 2016, place a duty on the waste generator to:
(A) Transport the waste directly to the nearest river or water body.
(B) Segregate construction and demolition waste and deposit it at collection centers.
(C) Burn the waste on-site to reduce volume.
(D) Mix the waste with municipal solid waste for disposal.

81. Consider the following key events in international environmental governance:
1. Stockholm Conference on Human Environment
2. Rio Earth Summit (UNCED)
3. Johannesburg Summit on Sustainable Development (WSSD)
4. Rio+20 Conference on Sustainable Development
5. UN Summit on Millennium Development Goals
Which of the above statement(s) is/are correct regarding the primary theme that connects these major UN conferences?
(A) A singular focus on climate change mitigation and the reduction of industrial carbon emissions.
(B) The evolving discourse on environment and the promotion of global sustainable development.
(C) The regulation of transboundary movement of hazardous wastes and toxic industrial chemicals.
(D) The protection of the stratospheric ozone layer through the phasing out of specific gases.

NODIA

82. What is the fundamental difference between an Environmental Audit and an Environmental Impact Assessment (EIA)?
(A) EIA is a tool for future prediction, while an audit is a tool for checking past and present performance.
(B) EIA is for existing facilities, while an audit is for proposed projects.
(C) EIA is voluntary, while an audit is always mandatory.
(D) EIA focuses only on pollution, while an audit focuses only on resource use.

(C) Secure renewed political commitment for sustainable development.
(D) Ban the international trade in hazardous waste.

118. Which international conference first recognized the need for a coordinated international approach to environmental problems?
(A) Rio Summit, 1992
(B) Stockholm Conference, 1972
(C) Johannesburg Summit, 2002
(D) Copenhagen Summit, 2009

119. Consider the following statements about the objectives of EIA:
1. To identify potential environmental impacts of a project.
2. To propose mitigation measures to minimize negative impacts.
3. To inform decision-makers and the public about the environmental implications.
4. To guarantee project approval regardless of impacts.
5. To maximize the economic profit of the project.

Which of the above statement(s) is/are correct?
(A) 1, 2, and 3 only
(B) 4 and 5 only
(C) 1, 2, 3, 4, and 5
(D) 1, 2, and 4 only

120. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Biological Diversity Act, 2002 establishes a three-tier structure comprising the National Biodiversity Authority, State Biodiversity Boards, and Biodiversity Management Committees.
Reason (R) : This structure is designed to facilitate decentralized management and conservation of biodiversity.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

121. The precautionary principle and the polluter pays principle are explicitly mentioned as part of the:
(A) National Water Policy, 2002
(B) National Forest Policy, 1988
(C) National Environmental Policy, 2006
(D) Indian Forest Act, Revised 1982

122. Under the EIA Notification 2006, the responsibility for conducting the EIA for a project lies with:
(A) The Project Proponent/Developer
(B) The Ministry of Environment and Forests
(C) The State Pollution Control Board
(D) A designated Non-Governmental Organization

123. The Coastal Regulation Zone (CRZ) rules are primarily aimed at:
(A) Promoting tourism in coastal areas without any restrictions.
(B) Facilitating construction of ports and harbors anywhere along the coastline.
(C) Nationalizing private properties located within 500 meters of the High Tide Line.
(D) Regulating developmental activities to protect fragile coastal ecosystems.

124. What is the relationship between the Environmental Impact Statement (EIS) and the Environmental Management Plan (EMP)?
(A) They are two independent documents with no connection.
(B) The EMP is a section within the EIS that outlines mitigation and management actions.
(C) The EIS is a part of the EMP.
(D) The EMP is prepared first, and the EIS is prepared only if the EMP is found inadequate.

125. The primary focus of the Ramsar Convention is the conservation and wise use of:
(A) Tropical Rainforests
(B) Deserts
(C) Wetlands
(D) Coral Reefs

126. Match List-I (Environmental Concept) with List-II (Description).
List I: (Environmental Concept)

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(C) Food Safety Management System
(D) Environmental Management System

92. The Public Liability Insurance Act, 1991, mandates that owners of enterprises handling hazardous substances must:
(A) Provide free housing to all employees.
(B) Take out an insurance policy to cover liability to third parties from accidents.
(C) Contribute a fixed percentage of profits to a national environmental fund.
(D) Conduct an environmental audit every five years.

93. Which of the following was a major outcome of the Earth Summit at Rio de Janeiro in 1992?
(A) The Montreal Protocol
(B) The Basel Convention
(C) Agenda 21
(D) The Stockholm Declaration

94. Consider the following statements:
Statement I : The EIA Notification, 2006, mandates prior environmental clearance for certain categories of projects.
Statement II : The purpose of this mandatory clearance is to ensure that environmental concerns are integrated into the project approval process.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

95. In the context of risk assessment, 'scenarios of exposure' analysis attempts to answer which question?
(A) Who or what is exposed, and through what pathway?
(B) What is the chemical composition of the hazard?
(C) How toxic is the hazardous substance?
(D) What is the financial cost of the potential damage?

96. Match List-I (International Body) with List-II (Main Function).
List I: (International Body)
P. IPCC
Q. UNEP
R. GEF
S. IGBP
List II: (Main Function)
1. Coordinates international research on global change
2. Provides funding for environmental projects
3. Assesses the science of climate change
4. Sets the global environmental agenda
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-2, R-4, S-1
(D) P-4, Q-1, R-2, S-3

97. The principle of 'polluter pays' is explicitly mentioned as a guiding principle in which policy document?
(A) National Forest Policy, 1988
(B) National Environmental Policy, 2006
(C) National Water Policy, 2002
(D) Indian Forest Act, Revised 1982

98. Which of the following activities is regulated by the Forest Conservation Act, 1980?
(A) Using forest land for non-forest purposes like mining or industry.
(B) Planting trees on private land.
(C) Collection of fallen leaves from a city park.
(D) Regulating noise levels in silent zones.

99. Arrange the following summits in reverse chronological order (most recent first):
1. Copenhagen Summit
2. Earth Summit at Johannesburg
3. RIO+20
4. Earth Summit at Rio de Janeiro
(A) 3, 1, 2, 4
(B) 4, 2, 1, 3
(C) 1, 3, 2, 4
(D) 3, 2, 1, 4

NODIA

100. A project is categorized as 'Category B' under the EIA Notification, 2006. What does this generally imply?
(A) The project requires no Environmental Impact Assessment.
(B) The project requires mandatory clearance from the Central Government Ministry of Environment and Forests.
(C) The project is prohibited in all circumstances.
(D) The project requires clearance from the State Level Environmental Impact Assessment Authority (SEIAA).

(D) It mandates a minimum thickness for plastic carry bags.

152. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : The Environmental (Protection) Act of 1986 grants significant powers to the Central Government.

Reason (R) : This was deemed necessary to create a comprehensive legal framework and fill gaps left by earlier, more specific legislation like the Water and Air Acts.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

153. A plan that outlines specific actions, timelines, and responsibilities for preventing pollution, conserving resources, and complying with environmental laws for an existing factory is called:

(A) An Environmental Impact Statement (EIS)
(B) A Project Feasibility Report
(C) An Environmental Management Plan (EMP)
(D) A Corporate Balance Sheet

154. The Conference of Parties (COP) is the main governing body of the UNFCCC. What was the number of the COP at which the Kyoto Protocol was adopted?

(A) COP 3 (Kyoto)
(B) COP 1 (Berlin)
(C) COP 15 (Copenhagen)
(D) COP 21 (Paris)

155. Which of the following Constitutional provisions was added by the 42nd Amendment Act, 1976, imposing a duty on the State to protect the environment?

(A) Article 21
(B) Article 19(1)(g)
(C) Article 51A(g)
(D) Article 48A

156. The process of identifying how a receptor (e.g., people, environment) might come into contact with a hazardous substance is known as:

(A) Hazard Identification
(B) Risk Management
(C) Risk Characterization
(D) Exposure Assessment

157. Match List-I (Rule) with List-II (Primary Subject Matter).

List I: (Rule)

P. The Solid Waste Management Rules, 2016
Q. The Hazardous and Other Waste Rules, 2016
R. The Bio-Medical Waste Management Rules, 2016
S. The e-waste (Management) Rules, 2016

List II: (Primary Subject Matter)

1. Waste from hospitals and clinics
2. Discarded refrigerators and computers
3. Municipal garbage
4. Industrial sludge and chemical residues

(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-2, R-3, S-4

158. The Indian Forest Act, Revised 1982, is a law that primarily serves to:

(A) Establish national parks and sanctuaries.
(B) Mandate compensatory afforestation.
(C) Implement the provisions of the Convention on Biological Diversity.
(D) Consolidate the law relating to forests, the transit of forest-produce, and the duty leviable on timber.

159. Consider the following statements about the Basel Convention:

1. It deals with the control of transboundary movements of hazardous wastes.
2. It aims to minimize the generation of hazardous wastes.
3. It was adopted in Basel, Switzerland, in 1989.
4. It encourages the dumping of waste from developed to developing countries.
5. It is primarily focused on reducing greenhouse gas emissions.

Which of the above statement(s) is/are correct?

(A) 1, 2, and 3 only

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specifies requirements for an effective EMS.
3. Adopting an EMS like ISO 14001 can lead to improved environmental performance and compliance.
4. An EMS is only applicable to large multinational corporations.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3 only
(B) 2 and 4 only
(C) 1 and 3 only
(D) 1, 2, 3 and 4

110. Which legal instrument in India governs the management and handling of discarded lead-acid batteries?
(A) The e-waste (Management) Rules, 2016
(B) The Hazardous and Other Waste Rules, 2016
(C) The Solid Waste Management Rules, 2016
(D) The Batteries (Management and Handling) Rules, 2010

111. The term Reviewing EIA of developmental projects refers to the process of:
(A) A critical examination of the EIA report by an expert committee and regulatory authority before a decision is made.
(B) The project proponent's internal review of their own EIA report.
(C) A post-project evaluation conducted ten years after project completion.
(D) A media review of the project's environmental impacts.

112. Match List-I (Legislation) with List-II (Key Subject).
List I: (Legislation)
P. Biological Diversity Act, 2002
Q. Public Liability Insurance Act, 1991
R. Noise Pollution (Regulation and Control) Rules, 2000
S. Forest Conservation Act, 1980
List II: (Key Subject)
1. Diversion of forest land
2. Ambient noise standards
3. Access and Benefit Sharing
4. Relief for accident victims of hazardous industries
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-3, R-2, S-1
(D) P-3, Q-4, R-2, S-1

113. The concept of Sustainable Development, famously defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs, was popularized by:
(A) The Stockholm Conference, 1972
(B) The Brundtland Commission Report, 1987
(C) The Montreal Protocol, 1987
(D) The Kyoto Protocol, 1997

114. The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, would apply to which of the following?
(A) Waste oil and contaminated sludge from an industrial process.
(B) Kitchen waste from a household.
(C) Discarded paper and cardboard from an office.
(D) Garden clippings and leaves.

115. A city government is trying to decide whether to build a new metro line. The analysis weighs the cost of construction and operation against benefits like reduced travel time, lower pollution from cars, and fewer accidents. This type of analysis is called:
(A) Life-Cycle Analysis
(B) Environmental Audit
(C) Cost-Benefit Analysis
(D) Risk Characterization

116. Consider the following statements:
Statement I : The National Environmental Policy, 2006, is a legally binding document that can be enforced in a court of law like an Act.
Statement II : The policy serves as a guideline for the government in decision-making and the formulation of laws and regulations related to the environment.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

117. One of the main goals of RIO+20 was to:
(A) Create a new legally binding treaty on climate change.
(B) Establish the Millennium Development Goals.

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83. Which act in India provides for the constitution of a Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs)?
(A) The Environmental (Protection) Act, 1986
(B) The Air (Prevention and Control of Pollution) Act, 1981
(C) The Water (Prevention and Control of Pollution) Act, 1974
(D) The Wildlife Protection Act, 1972

84. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Basel Convention restricts the transboundary movement of hazardous wastes, particularly from developed to less developed countries.
Reason (R) : This was in response to discoveries of toxic waste being dumped in developing nations without their knowledge or consent.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

85. Which of the following is NOT an aim of the National Environmental Policy, 2006?
(A) To conserve environmental resources.
(B) To ensure that all have access to clean environmental resources.
(C) To promote economic growth at the expense of environmental quality.
(D) To ensure that the benefits of environmental conservation are equally distributed.

86. The concept of Environmental planning as a part of EIA and Environmental Audit implies that:
(A) Planning is a minor afterthought once the final EIA report is formally submitted.
(B) Environmental considerations are integrated into core project design from the beginning.
(C) Environmental planning is solely the responsibility of centralized government agencies.
(D) Planning is limited to creating a basic green belt around the specific project site.

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87. Which of the following pairs is incorrectly matched?
(A) The Plastic Waste Management Rules - 2016
(B) The Bio-Medical Waste Management Rules - 2016
(C) The e-waste (Management) Rules - 2016
(D) The Batteries (Management and Handling) Rules - 2016

88. The Earth Summit at Johannesburg in 2002 was also known as:
(A) The World Summit on Sustainable Development
(B) The World Summit on Climate Change
(C) The Global Conference on Biodiversity
(D) The International Congress on Environmental Law

89. Consider the following statements about Cost-Benefit Analysis (CBA) in EIA:
1. It attempts to place monetary values on all project costs and benefits.
2. It is an objective and completely value-free analytical tool.
3. A project is considered viable if the benefit-cost ratio is greater than one.
4. It is often criticized for the difficulty in monetizing intangible environmental goods and services.

Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 1, 3 and 4 only
(C) 2 and 4 only
(D) 1, 2, 3 and 4

90. The amendment of 1987 to the Air (Prevention and Control of Pollution) Act, 1981 was significant because it:
(A) Brought noise pollution under the definition of air pollution.
(B) Reduced the powers of the State Pollution Control Boards.
(C) Excluded all industries from the Act's purview.
(D) Made the provisions of the Act non-binding.

91. The ISO 14001 standard is a specification for a/an:
(A) Quality Management System
(B) Occupational Health and Safety Management System

P. Environmental Impact Assessment (EIA)
Q. Life-Cycle Analysis (LCA)
R. Environmental Audit
S. Cost-Benefit Analysis (CBA)

List II: (Description)
1. A review of an existing operation's environmental performance.
2. A predictive tool for proposed projects.
3. An evaluation in monetary terms.
4. A cradle to grave assessment.

(A) P-1, Q-3, R-2, S-4
(B) P-2, Q-4, R-3, S-1
(C) P-2, Q-4, R-1, S-3
(D) P-4, Q-1, R-2, S-3

127. The amendment of the Air Act in 1987 to include 'noise' was a direct consequence of which provision in the Environmental (Protection) Act, 1986?
(A) The power of the central government to take all necessary measures for environmental protection.
(B) The mandate to establish national parks.
(C) The provision for public liability insurance.
(D) The requirement for environmental audits.

128. Arrange the following legal instruments chronologically by their first year of enactment/adoption:
1. The Air (Prevention and Control of Pollution) Act
2. The Environmental (Protection) Act
3. The Water (Prevention and Control of Pollution) Act
4. The Wildlife Protection Act

(A) 4, 3, 1, 2
(B) 3, 4, 1, 2
(C) 4, 1, 3, 2
(D) 3, 1, 4, 2

129. Consider the following statements:
Statement I : The Indian Forest Act (Revised 1982) is the principal legislation for the protection of biodiversity in India.
Statement II : The Biological Diversity Act, 2002 is the principal legislation for the protection of biodiversity, enacted to fulfill India's obligations under the CBD.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

130. The Clean Development Mechanism (CDM) is associated with which international agreement?
(A) Kyoto Protocol
(B) Basel Convention
(C) Montreal Protocol
(D) Ramsar Convention

131. Consider the following steps in a Risk Assessment process:
1. Hazard identification
2. Risk characterization
3. Hazard accounting
4. Scenarios of exposure

The logical sequence of these steps is:
(A) 1, 2, 3, 4
(B) 3, 1, 4, 2
(C) 1, 3, 2, 4
(D) 4, 3, 1, 2

132. The Water (Prevention and Control of Pollution) Cess Act, 1977 was introduced to:
(A) Penalize industries for non-compliance.
(B) Fund irrigation projects.
(C) Create a national water grid.
(D) Provide funds for the CPCB and SPCBs.

133. The National Environmental Policy of 2006 aims to mainstream environmental concerns in:
(A) Only industrial projects
(B) Only urban development
(C) All developmental activities
(D) Only agricultural practices

134. A manufacturing company wants to demonstrate its commitment to environmental protection by implementing a formal system to manage its environmental responsibilities. Which international standard series would be most appropriate for this purpose?
(A) ISO 9000 series
(B) ISO 14000 series
(C) ISO 26000 series
(D) ISO 22000 series

135. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Montreal Protocol has been one of the most successful international

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environmental agreements.

Reason (R) : It has resulted in a significant reduction in the global production and consumption of ozone-depleting substances.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

136. The management rules for Bio-Medical Waste, Plastic Waste, Solid Waste, e-waste, and Construction & Demolition Waste were all notified in 2016 under the umbrella of which parent Act?

(A) The Environmental (Protection) Act, 1986
(B) The Indian Forest Act, 1982
(C) The Water (Prevention and Control of Pollution) Act, 1974
(D) The Public Liability Insurance Act, 1991

137. Which of the following is NOT an aim or objective of Environmental Impact Assessment (EIA)?

(A) To identify, predict, and evaluate the foreseeable impacts of a project.
(B) To ensure that environmental issues are considered in project planning and decision making.
(C) To provide a justification for approving a project irrespective of its environmental impacts.
(D) To suggest mitigation measures for adverse impacts.

138. Which of the following statements correctly differentiates between the Forest Conservation Act, 1980 and the Indian Forest Act, Revised 1982?

(A) The 1980 Act regulates diversion of forest land, while the 1982 act deals with forest administration and transit of forest produce.
(B) The 1980 Act deals with forest conservation, while the 1982 act deals with specific wildlife protection and preservation efforts.
(C) The 1980 Act is a specific state law, while the 1982 act is an overarching central law for all geographical territories.
(D) There is no fundamental difference; they are exactly the same legislative act with different formal names in local contexts.

139. Consider the following pairs:

1. Montreal Protocol: Ozone Depleting Substances
2. Kyoto Protocol: Greenhouse Gases
3. Basel Convention: Hazardous Wastes
4. Ramsar Convention: Wetlands

Which of the above statement(s) is/are correct?

(A) 1 and 2 only
(B) 1, 2, and 3 only
(C) 3 and 4 only
(D) 1, 2, 3, and 4

140. A company manufacturing televisions is required by law to set up a system for collecting and recycling the televisions at the end of their useful life. This obligation is known as:

(A) Corporate Social Responsibility
(B) Extended Producer Responsibility
(C) Public Liability Insurance
(D) Due Diligence

141. The United Nations Framework Convention on Climate Change (UNFCCC) was one of the major outcomes of the:

(A) Stockholm Conference (1972)
(B) Montreal Protocol meeting (1987)
(C) Convention on Biological Diversity (CBD)
(D) Earth Summit at Rio de Janeiro (1992)

142. Match List-I (Term from EIA) with List-II (Meaning).

List I: (Term from EIA)

P. Screening
Q. Scoping
R. Mitigation
S. Monitoring

List II: (Meaning)

1. Identifying the key issues to be addressed in the EIA.
2. Determining whether an EIA is needed for a project.
3. Checking the effects of the project after implementation.
4. Measures to reduce or avoid adverse impacts.

(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-4, Q-1, R-2, S-3

143. Which of the following activities requires prior environmental clearance as per the EIA Notification, 2006?
(A) Constructing a new thermal power plant
(B) Painting a residential house
(C) Planting a tree in a public park
(D) Repairing a household appliance

144. The main purpose of the amendment of 1991 to the Wildlife Protection Act, 1972, was to provide for:
(A) The protection of specified wild animals, birds and plants and for the appointment of a director of wildlife preservation.
(B) Providing protection to specified plant species and regulating the trade of vulnerable and endangered species.
(C) Weaker penalties for poaching and the reduction of fines for the illegal trade of common animal products in local markets.
(D) Allowing commercial hunting in designated areas and the legal sale of ivory and other rare biological materials to international buyers.

145. The precautionary principle in environmental law suggests that:
(A) A substance should be considered harmful only after conclusive scientific proof of harm is available from multiple laboratories.
(B) Lack of scientific certainty shall not be used to postpone measures to prevent degradation when serious threats exist.
(C) All developmental activities should be stopped immediately to prevent any potential harm to the environment or human health.
(D) The burden of proof to show that a substance is harmful lies exclusively with the public and local non-governmental organizations.

146. Consider the following statements:
Statement I : The National Water Policy of 2002 gives first priority to drinking water in the allocation of water resources.
Statement II : The policy advocates for a decentralized, participatory approach to water management.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

147. What does the term Hazard Accounting in risk assessment refer to?
(A) Estimating the financial costs associated with a hazard.
(B) Holding specific individuals accountable for safety lapses.
(C) Documenting the location, quantity, and properties of hazardous substances.
(D) Narrating past accidents involving a particular hazard.

148. The Earth Summit at Johannesburg in 2002 was a follow-up to which major conference?
(A) The Stockholm Conference on Human Environment, 1972
(B) The Montreal Protocol Conference, 1987
(C) The Copenhagen Climate Summit, 2009
(D) The Rio de Janeiro Earth Summit, 1992

149. Consider the following components of environmental management:
1. Environmental Impact Assessment (EIA)
2. Life-Cycle Analysis (LCA)
3. Environmental Audit
4. Cost-Benefit Analysis

Which of the above statement(s) is/are correct regarding predictive tools used for proposed projects?
(A) 3 only
(B) 1, 2, and 4 only
(C) 1, 2, 3, and 4
(D) 3 and 4 only

150. According to the Noise Pollution (Regulation and Control) Rules, 2000, the use of loudspeakers is generally restricted between the hours of:
(A) 6:00 AM and 10:00 PM
(B) 10:00 PM and 6:00 AM
(C) 9:00 PM and 9:00 AM
(D) 8:00 PM and 8:00 AM

151. Which of the following is a key provision of the Plastic Waste Management Rules, 2016?
(A) It encourages the use of single-use plastic bags of any thickness.
(B) It exempts producers from any responsibility for waste management.
(C) It bans the use of all plastic products in the country.

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101. Consider the following statements regarding Environmental Law in India:
1. Article 48A of the Constitution is a Directive Principle of State Policy.
2. Article 51A(g) of the Constitution is a Fundamental Duty of citizens.
3. The Environmental (Protection) Act, 1986 was enacted under Article 253 of the Constitution.
4. The Water Act 1974 and Air Act 1981 predate the Environmental (Protection) Act.
5. The Wildlife Protection Act, 1972 is primarily for conserving agricultural crops.

Which of the above statement(s) is/are correct?
(A) 1, 2, 3 and 4 only
(B) 1, 2, 4 and 5 only
(C) 3, 4 and 5 only
(D) 1, 2, 3, 4 and 5

102. An eco-label on a product signifies that:
(A) The product is the cheapest in its category.
(B) The product meets certain environmental standards compared to other products in the same category.
(C) The product is guaranteed to last for a lifetime.
(D) The product is made from 100% recycled materials, without exception.

103. The amendment of 1988 to the Water (Prevention and Control of Pollution) Act, 1974, primarily aimed to:
(A) Exclude groundwater from the purview of the Act.
(B) Reduce the scope of the Act to only major rivers.
(C) Abolish the Central Pollution Control Board.
(D) Introduce stricter penalties and strengthen the powers of the pollution control boards.

104. Which one of the following is NOT a primary objective of the National Forest Policy, 1988?
(A) Maximizing revenue from forests to fund other government projects.
(B) Maintenance of environmental stability.
(C) Conserving the natural heritage of the country.
(D) Checking soil erosion and denudation.

105. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The EIA process includes a 'scoping' phase.
Reason (R) : Scoping is essential to identify the key and most significant environmental issues from a wide range of potential concerns for detailed investigation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

106. The UN Summit on Millennium Development Goals (2000) established a set of eight time-bound goals. Which goal is most directly related to the environment?
(A) Goal 7: Ensure environmental sustainability
(B) Goal 2: Achieve universal primary education
(C) Goal 5: Improve maternal health
(D) Goal 8: Develop a global partnership for development

107. Which of the following Acts provides a legal framework for the protection of all aspects of the environment in a holistic manner?
(A) The Water Act, 1974
(B) The Air Act, 1981
(C) The Forest Conservation Act, 1980
(D) The Environmental (Protection) Act, 1986

108. The main purpose of the Rules 1986 associated with the Environmental (Protection) Act, 1986 is to:
(A) Define the organizational structure of the Ministry of Environment.
(B) Provide detailed procedures and standards for implementing the Act's provisions.
(C) List the endangered species of India.
(D) Outline the goals of India's foreign environmental policy.

109. Consider the following statements:
1. An Environmental Management System (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts.
2. ISO 14001 is the international standard that

(B) 3, 4, and 5 only
(C) 1 and 4 only
(D) 1, 2, 3, 4, and 5

160. What is a key difference between the Montreal Protocol and the Kyoto Protocol?
(A) Montreal deals with climate change, while Kyoto deals with ozone depletion.
(B) Montreal deals with ozone depletion, while Kyoto deals with climate change.
(C) Montreal is a national policy of Canada, while Kyoto is a national policy of Japan.
(D) Montreal deals with hazardous waste, while Kyoto deals with biodiversity.

161. A document that details the results of an EIA study, including baseline data, impact prediction, and the EMP, is known as the:
(A) Environmental Impact Statement (EIS)
(B) Environmental Management Plan (EMP)
(C) Environmental Audit Report
(D) Risk Assessment Report

162. Consider the following statements:
Statement I : The Wildlife Protection Act, 1972, prohibits the hunting of animals listed in its schedules.
Statement II : The Act also provides for the establishment of zoos and the regulation of trade in wildlife products.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

163. A key objective of the National Forest Policy of 1988 is to have a minimum of what percentage of India's total land area under forest or tree cover?
(A) 10 percent
(B) 25 percent
(C) 33 percent
(D) 50 percent

164. The Copenhagen Summit in 2009 was notable for:
(A) The signing of a new legally binding climate treaty to replace the Kyoto Protocol.
(B) The establishment of the Global Environment Facility.
(C) The phasing out of chlorofluorocarbons (CFCs).
(D) The Copenhagen Accord, a non-binding political agreement.

165. The term 'environmental audit' refers to the evaluation of:
(A) The potential environmental impacts of a future project.
(B) The financial cost of environmental damage.
(C) The compliance and environmental performance of an existing operation or facility.
(D) The life cycle impacts of a product from cradle to grave.

166. A chemical factory is assessing potential accident scenarios, including leaks, fires, and explosions, and their possible consequences. This activity is a part of:
(A) Life-Cycle Analysis
(B) Risk Assessment
(C) Environmental Audit
(D) Cost-Benefit Analysis

167. The primary role of the IPCC (Intergovernmental Panel on Climate Change) is to:
(A) Fund climate-friendly projects in developing countries.
(B) Enforce the provisions of the Kyoto Protocol.
(C) Conduct its own climate research and data collection.
(D) Provide policy makers with regular scientific assessments on climate change.

168. Consider the following Acts:
1. Air (Prevention and Control of Pollution) Act, 1981
2. Water (Prevention and Control of Pollution) Act, 1974
3. Environmental (Protection) Act, 1986
4. Biological Diversity Act, 2002

Which of these Acts provides the Central Government with overriding powers to make rules for environmental protection on any subject?
(A) 3 only
(B) 1 only
(C) 2 only
(D) 4 only

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187. Which of the following is a key objective of the National Environmental Policy, 2006?
(A) To achieve economic growth by ignoring environmental costs.
(B) To privatize all forests and water bodies.
(C) To centralize all environmental decision-making power.
(D) To integrate environmental concerns into all stages of policy making.

188. Which of the following pairs of Act and its primary purpose is incorrectly matched?
(A) Water Act, 1974 - Prevention and control of water pollution.
(B) Air Act, 1981 - Prevention and control of air pollution.
(C) Wildlife Protection Act, 1972 - Regulation of industrial emissions.
(D) Forest Conservation Act, 1980 - Control of diversion of forest land.

189. Consider the following statements about India's waste management rules of 2016:
1. The Solid Waste Management Rules promote segregation of waste at source.
2. The e-waste Rules introduced the concept of Extended Producer Responsibility (EPR).
3. The Bio-Medical Waste Rules prescribe methods for treating infectious waste.
4. The Plastic Waste Rules aim to phase out single-use plastics and set thickness norms.
5. The C&D Waste Rules provide a framework for managing waste from construction activities.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3 only
(B) 1, 2, 3, 4, and 5
(C) 2, 4 and 5 only
(D) 1, 3 and 5 only

190. Which of the following is the best description of an Environmental Management System (EMS) as defined by the ISO 14000 series?
(A) A software program for tracking pollution data.
(B) A legal requirement for all companies worldwide.
(C) A government body that audits companies for environmental compliance.
(D) A voluntary framework that helps an organization achieve its environmental goals through consistent control of its operations.

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191. The primary focus of the Montreal Protocol of 1987 is:
(A) Protecting the stratospheric ozone layer.
(B) Protecting endangered species.
(C) Combating desertification.
(D) Reducing greenhouse gas emissions.

192. The Water (Prevention and Control of Pollution) Act, 1974 was amended in:
(A) 1986
(B) 1988
(C) 1987
(D) 1991

193. The main outcome of the Earth Summit at Johannesburg, 2002 was the:
(A) Kyoto Protocol
(B) Johannesburg Plan of Implementation
(C) Agenda 21
(D) Montreal Protocol

194. Consider the following statements:
Statement I : Life-Cycle Analysis (LCA) considers environmental impacts during the entire life of a product, from raw material acquisition to disposal.
Statement II : Environmental Audit assesses the environmental performance of an existing industrial operation against set criteria.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

195. The Public Liability Insurance Act, 1991, aims to provide immediate relief to victims of accidents involving:
(A) Road traffic
(B) Natural disasters
(C) Hazardous substances
(D) Medical negligence

196. The 1991 amendment to the Wildlife Protection Act, 1972, was particularly significant for:
(A) Banning the hunting of all animals without exception.
(B) Establishing the National Tiger Conservation Authority.

178. The Solid Waste Management Rules, 2016, apply to:
(A) Every urban local body, outgrowths in urban agglomerations, census towns, notified industrial townships, and other areas.
(B) Only urban areas and municipalities.
(C) Only rural areas and panchayats.
(D) Only industrial estates and special economic zones.

179. Consider the following statements:
Statement I : The Forest Conservation Act, 1980 was enacted to regulate the cutting of trees in private properties.
Statement II : The Act's primary objective is to check the diversion of forest land for non-forest purposes.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

180. The process of analyzing the financial feasibility of a project by comparing its total monetary costs with its total monetary benefits is called:
(A) Environmental Impact Assessment
(B) Life-Cycle Analysis
(C) Risk Management
(D) Cost-Benefit Analysis

181. Consider the following key events in international environmental governance:
1. The EP Act, 1986, gives power to the Central Government to set emission and effluent standards.
2. The Water Act, 1974, led to the creation of Central and State Pollution Control Boards.
3. The Air Act, 1981, initially did not include noise as a pollutant.
4. The Wildlife Protection Act, 1972, provides for the creation of National Parks.

Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 1, 2 and 3 only
(C) 3 and 4 only
(D) 1, 2, 3 and 4

182. The Ecomark scheme in India is a labeling system for:
(A) Organic food products
(B) Environmentally friendly consumer products
(C) Energy-efficient electronic appliances
(D) Export-quality handicrafts

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183. Which conference is also known as the United Nations Conference on Environment and Development (UNCED)?
(A) Stockholm Conference, 1972
(B) Johannesburg Summit, 2002
(C) RIO+20, 2012
(D) Earth Summit at Rio de Janeiro, 1992

184. The amendment to the Manufacture, Storage and Import of Hazardous Chemical Rules in 2000 was intended to:
(A) Strengthen the rules and bring them in line with international standards.
(B) Relax the rules for importing hazardous chemicals.
(C) Ban the domestic manufacture of all hazardous chemicals.
(D) Transfer the regulatory power from the central to state governments.

185. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : An Environmental Management Plan (EMP) is a static document that, once created, should not be changed.
Reason (R) : An EMP must be a dynamic document, adaptable to changing conditions and the results of environmental monitoring.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

186. The concept of Risk characterization in risk assessment involves:
(A) Combining information from exposure and toxicity assessments to estimate the probability and severity of an adverse effect.
(B) Identifying all potential hazards.
(C) Describing how people might be exposed to a hazard.
(D) Deciding what actions to take to control the risk.

169. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : The EIA Notification 2006 makes public consultation a mandatory step for many projects.

Reason (R) : This ensures that the concerns of the local affected people and other stakeholders are heard and considered in the decision-making process.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

170. Which of the following is NOT a provision under the Bio-Medical Waste Management Rules, 2016?

(A) Encouraging the mixing of bio-medical waste with municipal solid waste.
(B) Segregation of waste into different colour-coded bags.
(C) Treatment and disposal of waste as per prescribed methods.
(D) Authorization for healthcare facilities by the prescribed authority.

171. The wise use of all wetlands is a fundamental principle promoted by which convention?

(A) Basel Convention
(B) Montreal Protocol
(C) UNFCCC
(D) Ramsar Convention

172. The National Water Policy of 2002 was formulated to address:

(A) The specific issue of river pollution from industrial sources only.
(B) The governance of water resources, including planning, development, and management.
(C) The construction of large dams as the only solution for water scarcity.
(D) The regulation of mineral water bottling companies.

173. The Global Environment Facility (GEF) acts as a financial mechanism for which of the following conventions?

(A) Montreal Protocol and Kyoto Protocol
(B) Convention on Biological Diversity and UNFCCC
(C) Ramsar Convention and Basel Convention
(D) Only the Convention on Biological Diversity

174. A Life-Cycle Analysis (LCA) of a plastic bottle would include all of the following stages EXCEPT:

(A) Extraction of petroleum for making plastic.
(B) Manufacturing of the bottle.
(C) Transportation and use of the bottle.
(D) The personal income of the consumer who buys the bottle.

175. What was the main agenda of the UN Summit on Millennium Development Goals in 2000?

(A) To set specific targets for poverty reduction, health, education, and environmental sustainability.
(B) To create a new framework for international trade.
(C) To negotiate a successor to the Kyoto Protocol.
(D) To address the global financial crisis.

176. Which of these is an umbrella legislation that gives the central government comprehensive powers to protect the environment?

(A) Water Act, 1974
(B) Environment (Protection) Act, 1986
(C) Air Act, 1981
(D) Wildlife Protection Act, 1972

177. Match List-I (Event/Agreement) with List-II (Year).

List I: (Event/Agreement)
P. Montreal Protocol
Q. Rio Earth Summit
R. Stockholm Conference
S. Kyoto Protocol Adoption

List II: (Year)
1. 1992
2. 1997
3. 1972
4. 1987

(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-3, S-4

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(C) Doubling the size of all National Parks.
(D) Including provisions for the protection of specified plants.

197. Which of the following conventions focuses on controlling the international trade and movement of hazardous waste?
(A) Ramsar Convention
(B) Convention on Biological Diversity
(C) UNFCCC
(D) Basel Convention

198. The 'pre-construction' and 'pre-operational' stages of a project are the primary focus of which environmental tool?
(A) Environmental Audit
(B) Environmental Impact Assessment
(C) Post-facto evaluation
(D) Environmental Monitoring

199. Consider the following:
1. United Nations Environment Programme (UNEP)
2. Intergovernmental Panel on Climate Change (IPCC)
3. International Geosphere-Biosphere Programme (IGBP)
4. Global Environmental Facility (GEF)

Which of the above statement(s) is/are correct regarding a financing mechanism for environmental conventions?
(A) 1 only
(B) 2 only
(C) 3 only
(D) 4 only

200. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Air (Prevention and Control of Pollution) Act, 1981 empowers State Pollution Control Boards to declare air pollution control areas.
Reason (R) : This allows for focused regulatory measures and stricter standards in areas with high levels of air pollution.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

201. Which of the following represents the correct pairing of an environmental law and its year of enactment?
(A) Environmental (Protection) Act - 1972
(B) Wildlife Protection Act - 1986
(C) Water (Prevention and Control of Pollution) Act - 1974
(D) Air (Prevention and Control of Pollution) Act - 1988

202. The concept of equitable benefit sharing from the use of genetic resources is a key component of:
(A) The Forest Conservation Act, 1980
(B) The Biological Diversity Act, 2002
(C) The Environmental (Protection) Act, 1986
(D) The National Forest Policy, 1988

203. A key feature of the Batteries (Management and Handling) Rules is the principle of:
(A) Polluter Pays
(B) Precautionary Principle
(C) User Responsibility
(D) Extended Producer Responsibility

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204. The EIA Notification 2006 and its amendments are issued under the powers conferred by:
(A) The Water Act, 1974
(B) The Air Act, 1981
(C) The Environmental (Protection) Act, 1986
(D) The Indian Constitution directly

205. The primary purpose of an Environmental Management Plan (EMP) is to:
(A) Provide a detailed description of the existing environment.
(B) Justify the economic benefits of a project.
(C) Outline the practical actions to mitigate and manage the environmental impacts identified in the EIA.
(D) List all the environmental laws applicable to a project.

206. Consider the following statements:
Statement I : The Stockholm Conference of 1972 was the first global conference on the environment.
Statement II : The Rio Summit of 1992 was the first global conference to focus on the concept of

(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

225. The e-waste (Management) Rules, 2016, introduced the principle of Extended Producer Responsibility (EPR). This means that the producer is responsible for:
(A) The quality and safety of the electronic product during its use.
(B) Providing a warranty for the product.
(C) The channelization of e-waste to ensure environmentally sound management.
(D) Selling the product at the lowest possible price.

226. What was the most significant outcome of the United Nations Conference on the Human Environment held in Stockholm in 1972?
(A) The creation of the United Nations Environment Programme (UNEP).
(B) The signing of the Kyoto Protocol.
(C) The adoption of Agenda 21.
(D) The establishment of the Global Environment Facility (GEF).

227. In the context of EIA, what is the main purpose of scoping?
(A) To identify the most significant issues and impacts that need to be addressed in the EIA study.
(B) To determine the geographical boundary of the project.
(C) To calculate the final cost of the project.
(D) To conduct a public hearing about the project.

228. The Biological Diversity Act, 2002 was enacted to give effect to the provisions of which international convention?
(A) The Ramsar Convention
(B) The Convention on Biological Diversity (CBD)
(C) The Basel Convention
(D) The UNFCCC

229. Match List-I (Environmental Conference) with List-II (Key Theme/Outcome).
List I: (Environmental Conference)
P. Rio Earth Summit, 1992
Q. Johannesburg Summit, 2002
R. Stockholm Conference, 1972
S. RIO+20, 2012
List II: (Key Theme/Outcome)
1. Plan of Implementation for Sustainable Development
2. The Future We Want
3. Only One Earth
4. Agenda 21
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

230. The Construction and Demolition Waste Management Rules, 2016, apply to:
(A) Everyone who generates construction and demolition waste.
(B) Only large real estate developers.
(C) Only government construction projects.
(D) Only the demolition of old bridges.

231. The primary focus of the ISO 14000 family of standards is:
(A) Product quality
(B) Environmental management
(C) Financial management
(D) Worker safety

232. Consider the following Waste Management Rules notified in 2016 and arrange them in alphabetical order:
1. The e-waste (Management) Rules
2. The Plastic Waste Management Rules
3. The Bio-Medical Waste Management Rules
4. The Solid Waste Management Rules
Which of the above statement(s) is/are correct regarding the alphabetical sequence?
(A) 3, 1, 2, 4
(B) 1, 2, 3, 4
(C) 4, 3, 2, 1
(D) 2, 1, 4, 3

233. The main contribution of the UN Summit on Millennium Development Goals (2000) was the establishment of:
(A) A set of eight time-bound development goals.
(B) A global fund for environmental protection.
(C) A new international court for environmental crimes.

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wetlands.
(B) The protection of the ozone layer.
(C) The control of transboundary movements of hazardous wastes.
(D) The conservation of migratory species.

216. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Solid Waste Management Rules, 2016, mandate waste segregation at the source.
Reason (R) : Segregation at the source improves the efficiency of recycling and reduces the amount of waste sent to landfills.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

217. A company performs a periodic check of its operations against environmental laws and its own environmental policies. This process is known as:
(A) An Environmental Impact Assessment
(B) An Environmental Audit
(C) A Life-Cycle Analysis
(D) A Risk Assessment

218. The provisions of the Motor Vehicle Act, 1988, related to the environment primarily deal with:
(A) Road safety measures
(B) Licensing of drivers
(C) Standards for vehicular emissions and noise
(D) The manufacturing cost of vehicles

219. Consider the following statements about the objectives of EIA:
1. To ensure environmental considerations are integrated into project design.
2. To predict potential adverse environmental impacts.
3. To propose measures to mitigate adverse impacts.
4. To provide a platform for public participation in the decision-making process.
5. To find a reason to reject every developmental project.

Which of the above statement(s) is/are correct?
(A) 1, 2, 3 and 4 only
(B) 1 and 2 only
(C) 5 only
(D) 1, 2, 3, 4 and 5

220. The primary purpose of the Cost-Benefit Analysis (CBA) in the context of an EIA is to:
(A) Assess the biological diversity of the project area.
(B) Compare the economic advantages of a project against its economic disadvantages, including monetized environmental impacts.
(C) Determine the public opinion about the project.
(D) Create a plan for managing environmental impacts.

221. Which constitutional amendment introduced Article 48A and Article 51A(g), dealing with environment protection, into the Indian Constitution?
(A) 40th Amendment
(B) 42nd Amendment
(C) 44th Amendment
(D) 73rd Amendment

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222. The term Scenarios of exposure is a critical component of:
(A) Environmental Auditing
(B) Life-Cycle Analysis
(C) Risk Assessment
(D) Cost-Benefit Analysis

223. The National Environmental Policy of 2006 is best described as:
(A) A policy document that guides the actions of different ministries and government agencies.
(B) A legally binding statute with punitive provisions.`
(C) An international treaty signed by India.
(D) A set of rules specifically for industrial pollution.

224. Consider the following statements:
Statement I : The Basel Convention deals with the control of transboundary movements of hazardous wastes and their disposal.
Statement II : The Montreal Protocol deals with the phasing out of ozone-depleting substances.

(B) Static and unchangeable.
(C) Repealed and no longer in effect.
(D) Valid for only one year at a time.

243. The primary financial mechanism for the UNFCCC and the Convention on Biological Diversity is the:
(A) Global Environment Facility (GEF)
(B) World Bank
(C) International Monetary Fund (IMF)
(D) United Nations Development Programme (UNDP)

244. The Air (Prevention and Control of Pollution) Act was amended in 1987 to bring which pollutant under its purview?
(A) Noise
(B) Carbon dioxide
(C) Methane
(D) Particulate matter

245. Agenda 21 is a comprehensive blueprint for action to be taken globally, nationally, and locally by organizations of the UN System, Governments, and Major Groups in every area in which human impacts on the environment. This was an outcome of the:
(A) Earth Summit at Rio de Janeiro, 1992
(B) Stockholm Conference, 1972
(C) Johannesburg Summit, 2002
(D) Copenhagen Summit, 2009

246. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The Public Liability Insurance Act, 1991, was enacted to provide immediate relief to victims of accidents involving hazardous substances.
Reason (R) : The Act is based on the principle of no-fault liability, meaning victims can receive compensation without having to prove negligence.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

247. The National Environmental Policy, 2006 of India, advocates which of the following principles?
(A) The Polluter Pays principle.
(B) The Growth First, Environment Later principle.
(C) The Centralization of all Environmental Powers principle.
(D) The Exemption for Small Industries principle.

248. The primary function of an Environmental Management Plan (EMP) within an EIA report is to:
(A) Propose a set of mitigation, management, monitoring, and institutional measures to eliminate, offset, or reduce adverse environmental impacts.
(B) Detail the project's economic costs and benefits.
(C) Describe the baseline environmental conditions.
(D) Provide a summary of the project's technical specifications.

249. Which of the following correctly matches the international agreement with its primary objective?
(A) Montreal Protocol – Protection of the ozone layer
(B) Kyoto Protocol – Control of hazardous waste
(C) Basel Convention – Reduction of greenhouse gases
(D) Ramsar Convention – Protection of biodiversity in general

250. The six waste management rules notified by the Indian government in 2016 (Solid, Plastic, Bio-medical, Hazardous, e-waste, C&D waste) were all promulgated under the authority of which parent legislation?
(A) The Environment (Protection) Act, 1986
(B) The Indian Penal Code, 1860
(C) The Water (Prevention and Control of Pollution) Act, 1974
(D) The Factories Act, 1948

Direction : Please read the following source carefully.

Environmental Impact Assessment (EIA) is a systematic process designed to predict and evaluate

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(D) A treaty on climate change.

234. In India, prior environmental clearance for certain projects is mandated under the provisions of:
(A) The Water Act, 1974
(B) The EIA Notification, 2006 issued under the Environment (Protection) Act, 1986
(C) The Air Act, 1981
(D) The Wildlife Protection Act, 1972

235. The primary objective of the National Forest Policy, 1988, is to:
(A) Ensure environmental stability and maintain ecological balance.
(B) Maximize revenue from forest resources.
(C) Promote the conversion of forest land to agricultural land.
(D) Encourage the export of timber.

236. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Article 51A(g) of the Indian Constitution makes it a fundamental duty for every citizen to protect the environment.
Reason (R) : This provision is legally enforceable by courts, and citizens can be punished for its violation without any specific enabling law.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

237. Which of the following is an example of an eco-labeling scheme in practice?
(A) An Ecomark label on a soap that indicates it is less harmful to the environment.
(B) The brand name of a company.
(C) The nutritional information label on a food package.
(D) The price tag on a product.

238. Consider the following statements:
Statement I : The Kyoto Protocol established binding emission reduction targets for all signatory countries, including both developed and developing nations.
Statement II : The Protocol operates on the principle of common but differentiated responsibilities, placing a heavier burden on developed countries.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

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239. The term Hazard Accounting in risk assessment refers to:
(A) Calculating the financial loss from an accident.
(B) Creating an inventory of the quantity and location of hazardous materials.
(C) Holding individuals responsible for safety.
(D) Auditing the safety procedures of a facility.

240. Consider the following about international environmental efforts:
1. Montreal Protocol addresses ozone depletion.
2. Basel Convention addresses transboundary movement of hazardous waste.
3. Ramsar Convention addresses wetland conservation.
4. Kyoto Protocol addresses greenhouse gas reduction.

Which of the above statement(s) is/are correct?
(A) 1 and 4 only
(B) 1, 2, and 3 only
(C) 2, 3 and 4 only
(D) 1, 2, 3, and 4

241. A project proponent hires a consultant to evaluate the environmental impacts of a proposed new highway. The consultant prepares a detailed report outlining the potential effects on air quality, noise levels, water drainage, and local wildlife, and suggests alternative routes and mitigation measures. This report is an:
(A) Environmental Impact Statement (EIS)
(B) Environmental Audit Report
(C) Annual Financial Statement
(D) Risk Management Plan

242. The amendments from time to time mentioned for Coastal Regulation Zones (CRZ), 1991, implies that the rules are:
(A) Subject to periodic review and modification based on new knowledge and changing needs.

sustainable development.
(A) Both Statement I and Statement II are true.
(B) Both Statement I and Statement II are false.
(C) Statement I is true, but Statement II is false.
(D) Statement I is false, but Statement II is true.

207. Which of the following is NOT an objective of the National Water Policy, 2002?
(A) To provide for the planning and development of water resources.
(B) To establish a standardized national framework for water management.
(C) To grant ownership of all river water to the private sector.
(D) To prioritize drinking water supply for human beings and animals.

208. The term 'Hazard Identification' in the context of risk assessment is the process of:
(A) Determining if a particular chemical or physical agent has the potential to cause harm.
(B) Quantifying the dose-response relationship for a substance.
(C) Estimating the frequency and duration of exposure.
(D) Deciding on the appropriate regulatory action.

209. Match List-I (Legislation) with List-II (Core Area).
List I: (Legislation)
P. The Motor Vehicle Act, 1988
Q. The Indian Forest Act, Revised 1982
R. The Bio-Medical Waste Management Rules, 2016
S. The e-waste (Management) Rules 2016
List II: (Core Area)
1. Transit of forest produce
2. Vehicular emission standards
3. Extended Producer Responsibility for electronics
4. Segregation and disposal of hospital waste
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-3, Q-1, R-4, S-2

210. Consider the following statements about the Wildlife Protection Act, 1972:
1. It has schedules which give varying degrees of protection to specified fauna.
2. It prohibits the trade in articles made from certain animal parts.
3. Its 1991 amendment added provisions for the protection of specified plants.
4. It is enforced by the Forest Department.
Which of the above statement(s) is/are correct?
(A) 1 and 3 only
(B) 1, 2, and 4 only
(C) 2 and 4 only
(D) 1, 2, 3, and 4

211. Which international agreement specifically addresses the issue of ozone-depleting substances?
(A) Kyoto Protocol
(B) Basel Convention
(C) Ramsar Convention
(D) Montreal Protocol

212. The concept of Life-Cycle Assessment is also known as:
(A) Cradle-to-grave analysis
(B) Cost-benefit analysis
(C) Environmental audit
(D) Risk management

213. The main objective of the Forest Conservation Act, 1980 is to:
(A) Promote social forestry.
(B) Regulate the hunting of wild animals.
(C) Increase the production of timber.
(D) Check the indiscriminate diversion of forest lands for non-forest purposes.

214. Which of the following is a correct statement regarding the Environmental (Protection) Act, 1986?
(A) It applies only to the control of water pollution.
(B) It empowers the Central Government to take all measures necessary to protect the environment.
(C) It was enacted before the Bhopal Gas Tragedy.
(D) It has been repealed and replaced by the National Green Tribunal Act.

215. The Ramsar Convention is an international treaty for:
(A) The conservation and sustainable use of

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the potential environmental consequences of a proposed developmental project or policy. The primary aim of EIA is to provide decision-makers with a comprehensive understanding of these impacts before a final decision is made, thereby integrating environmental considerations into the planning and design stages. Key outputs of this process include the Environmental Impact Statement (EIS), which is a detailed report documenting the findings of the assessment, and the Environmental Management Plan (EMP), which outlines the specific mitigation measures, monitoring programs, and institutional arrangements required to minimize, offset, or eliminate adverse environmental effects. EIA Guidelines provide a structured framework and standardized instructions for conducting the assessment, ensuring consistency and quality. The ultimate objective is not merely to identify negative impacts, but to foster environmentally sound and sustainable development by proposing viable alternatives and mitigation strategies. This proactive approach contrasts with reactive measures, as it seeks to prevent environmental degradation at its source rather than addressing it after the fact. The procedure for reviewing the EIA of developmental projects is a critical step that ensures the assessment's objectivity, completeness, and adherence to regulatory standards before granting environmental clearance.

Based on the above source, attempt the following five questions.

251. What is the principal objective of an Environmental Impact Assessment (EIA)?
(A) To exclusively document the economic benefits of a developmental project.
(B) To provide decision-makers with information to integrate environmental factors into project planning.
(C) To retroactively manage environmental damage caused by completed projects.
(D) To replace the need for an Environmental Management Plan.

252. Which component of the EIA process specifically details the mitigation measures and monitoring programs for a project?
(A) The Environmental Management Plan (EMP).
(B) The Environmental Impact Statement (EIS).
(C) The EIA Guidelines.
(D) The project's final decision document.

253. Based on the paragraph, the relationship between an Environmental Impact Statement (EIS) and an Environmental Management Plan (EMP) can be best described as:
(A) The EIS is a part of the EMP.
(B) The EMP is a summary of the EIS findings.
(C) The EIS documents the impacts, while the EMP proposes solutions to manage them.
(D) The EIS and EMP are interchangeable documents with the same purpose.

254. The paragraph suggests that the EIA process promotes sustainable development primarily by:
(A) Halting all projects with any potential for negative environmental impact.
(B) Focusing only on the long-term economic viability of a project.
(C) Deferring environmental considerations until after a project has been approved.
(D) Encouraging proactive prevention of environmental harm through planning and mitigation.

255. What is the described function of the procedure for reviewing an EIA?
(A) To ensure the project's financial profitability.
(B) To draft the initial Environmental Impact Statement.
(C) To verify the assessment's objectivity and compliance with standards.
(D) To replace the need for EIA Guidelines.

Direction : Please read the following source carefully.

The methodologies employed in Impact Assessment are diverse, designed to suit various types of projects and environmental settings. A critical aspect of the assessment framework involves a procedural review of the EIA for developmental projects, which scrutinizes the report for accuracy and thoroughness before approval. Beyond the initial impact prediction, advanced analytical tools are integrated to provide a more holistic evaluation. Life-cycle analysis (LCA), for instance, assesses the environmental impacts associated with all stages of a product's life, from raw material extraction through to processing, manufacture, distribution, use, and disposal or recycling. This

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278. What is the relationship between the Environmental (Protection) Act, 1986, and earlier laws like the Water Act, 1974, and the Air Act, 1981?
(A) The EPA, 1986, made the earlier acts null and void.
(B) The EPA, 1986, serves to coordinate and fill gaps left by the earlier acts.
(C) The earlier acts provide the authority for the EPA, 1986.
(D) The EPA, 1986, is a sub-section within the Water Act, 1974.

279. A primary function of the Environmental (Protection) Act, 1986, as described in the text, is to:
(A) Focus solely on the trans boundary movement of hazardous waste.
(B) Regulate the noise levels from motor vehicles.
(C) Confer powers upon the Central Government to create specific environmental regulations.
(D) Establish the constitutional duties of Indian citizens.

280. The context provided suggests that the enactment of the Environmental (Protection) Act, 1986, was significantly prompted by:
(A) The need to comply with an international treaty.
(B) The promulgation of the National Environmental Policy.
(C) The need to specifically manage plastic waste.
(D) A major industrial disaster, the Bhopal Gas Tragedy.

Direction : Please read the following source carefully.

The legal framework for environmental management extends to a variety of specific waste streams and economic sectors, each governed by dedicated rules. Building upon the authority of parent acts, these regulations provide detailed operational guidelines. The Solid Waste Management Rules, 2016, for example, modernized the approach to municipal solid waste by emphasizing segregation at source, recovery, and recycling. Similarly, The e-waste (Management) Rules, 2016, introduced the concept of Extended Producer Responsibility (EPR), making producers responsible for the collection and channelization of electronic waste. Another specific domain is covered by The Construction and Demolition Waste Management Rules, 2016, which aims to manage the vast quantities of inert waste generated from building activities. Beyond waste, sectoral regulations are also prominent. The Motor Vehicle Act, 1988, for instance, contains provisions to control vehicular emissions, a major source of air pollution. The management of specific hazardous products is addressed by rules such as The Batteries (Management and Handling) Rules, 2010 (with amendments), and The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000. To address liabilities, The Public Liability Insurance Act, 1991, mandates that handlers of hazardous substances take out insurance policies to provide immediate relief to potential victims of an accident.

Based on the above source, attempt the following five questions.

281. What key concept was introduced by The e-waste (Management) Rules, 2016, to manage electronic waste?
(A) Extended Producer Responsibility (EPR).
(B) Segregation of waste at source.
(C) The Public Liability Insurance requirement.
(D) Control of vehicular emissions.

282. The primary objective of The Public Liability Insurance Act, 1991, as described, is to:
(A) Regulate the import of hazardous chemicals.
(B) Ensure handlers of hazardous substances can provide immediate compensation to accident victims.
(C) Manage waste from construction and demolition activities.
(D) Set emission standards for motor vehicles.

283. Which of the following rules specifically addresses waste generated from building activities?
(A) The Solid Waste Management Rules, 2016.
(B) The Construction and Demolition Waste Management Rules, 2016.
(C) The e-waste (Management) Rules, 2016.
(D) The Batteries (Management and Handling) Rules, 2010.

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awarding a label to products that meet specific environmental criteria, eco-labeling encourages manufacturers to design and produce more sustainable goods, influencing both production and consumption patterns towards greater environmental responsibility.

Based on the above source, attempt the following five questions.

261. What is the primary purpose of the ISO 14000 series of standards?
(A) To legally mandate the EIA process for all industries.
(B) To function as an eco-labeling scheme for consumer products.
(C) To replace the EIA Notification, 2006.
(D) To provide a voluntary framework for an organization's Environmental Management System.

262. How do eco-labeling schemes aim to promote environmental responsibility?
(A) By legally prohibiting the sale of non-compliant products.
(B) By informing consumers to create market demand for environmentally friendly products.
(C) By providing financial subsidies to all manufacturers.
(D) By conducting mandatory environmental audits on all companies.

263. The paragraph draws a distinction between the ISO 14000 series and the EIA Notification, 2006, which can be characterized as:
(A) National scheme versus international law.
(B) Product-focused label versus process-focused audit.
(C) Voluntary system standard versus mandatory legal requirement.
(D) Market-based instrument versus corporate policy.

264. The implementation of an Environmental Management System based on the ISO 14000 series is described as a cyclical process involving:
(A) Hazard identification, risk characterization, and risk management.
(B) Cost-benefit analysis and life-cycle assessment.
(C) EIS preparation, public hearing, and project appraisal.
(D) Planning, implementation, review, and continual improvement.

265. Based on the passage, which of the following is an intended outcome of both the ISO 14000 series and eco-labeling schemes?
(A) Influencing organizational and consumer behavior towards sustainability.
(B) Guaranteeing environmental clearance for new projects.
(C) Mandating specific pollution control technologies for all industries.
(D) Sanctioning countries that fail to meet climate targets.

Direction : Please read the following source carefully.

Risk Assessment is a structured methodology for evaluating the potential for adverse effects on human health or the environment resulting from exposure to certain hazards. The process is systematically broken down into several distinct, sequential stages. It begins with Hazard Identification, which involves determining whether a particular chemical or physical agent has the potential to cause harm. Following this, Hazard Accounting quantifies the extent of the hazard, for instance, by assessing the amount of a hazardous substance that could be released. The next crucial stage involves defining Scenarios of Exposure, which describe how and to what extent receptors, such as human populations or ecosystems, might come into contact with the hazard. This stage considers the pathways, duration, and frequency of exposure. Subsequently, Risk Characterization integrates the information from the previous stages to estimate the incidence and severity of adverse effects likely to occur in a defined population. This stage synthesizes the hazard and exposure data to provide a comprehensive picture of the risk. The final stage, Risk Management, is distinct from assessment; it is the process of evaluating and selecting regulatory and non-regulatory response options to mitigate or manage the identified and characterized risks, taking into account scientific, economic, social, and political factors.

Based on the above source, attempt the following five questions.

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ANSWERS

1. (B) To predict impacts early in planning, identify reduction methods, and adapt projects to the local environment.
Environmental Impact Assessment aims to predict potential environmental consequences of developmental projects early in the planning stage. This process enables decision-makers to identify methods for reducing adverse effects and adapting projects to suit the local environment. By integrating ecological concerns into the design phase, it ensures that industrial growth proceeds sustainably without causing irreversible damage to the surrounding biological and geological systems.

2. (D) Statement I is false, but Statement II is true.
The Environmental Impact Statement is a technical report providing detailed information on project impacts, while the final decision document is typically the Environmental Clearance issued by authorities. Conversely, an Environmental Management Plan is a comprehensive framework detailing specific mitigation, monitoring, and institutional measures required to manage environmental impacts throughout the project life. Therefore, the description of the management plan is accurate, whereas the statement regarding the decision document is incorrect.

3. (C) Risk mitigation funding
Standard risk assessment procedures involve identifying potential hazards, characterizing risks, and evaluating exposure scenarios to understand potential harms to human health or the environment. While mitigation measures are developed based on these scientific assessments, the actual funding for such activities is an administrative and financial matter rather than a technical step in the scientific assessment process. Consequently, identifying financial resources is excluded from the technical risk evaluation cycle.

4. (D) Environmental Impact Assessment
A study conducted before the construction of a new facility to evaluate potential effects on air, water, and wildlife represents an Environmental Impact Assessment. This anticipatory tool helps in identifying foreseeable environmental risks and proposing measures to minimize harm. Unlike an audit which evaluates existing operations, this assessment is a predictive process that ensures environmental safeguards are integrated into the project planning and decision-making stages.

5. (C) Article 48A
Article 48A of the Indian Constitution is a Directive Principle of State Policy that mandates the protection and improvement of the environment. It specifically directs the State to make efforts to safeguard the country's forests and wildlife. This constitutional provision provides the legal foundation for various national environmental laws and policies, ensuring that the government remains committed to maintaining ecological balance and protecting natural biological resources.

6. (D) A is false but R is true.
The ISO 14000 series of international standards provides a strategic framework for managing an organization's environmental responsibilities rather than focusing on specific product quality or safety attributes. These voluntary standards guide the development of environmental policies, planning, and operational actions to minimize ecological footprints. While product safety is addressed by other ISO series, these particular standards are dedicated to improving overall environmental management performance and operational efficiency.

7. (D) National Environmental Policy, 2006
The Precautionary Principle is a fundamental guiding element of the National Environmental Policy of 2006. It suggests that where there are threats of serious or irreversible damage, a lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation. This principle ensures that developmental activities are approached with caution to prevent potential ecological harm even before scientific proof is established.

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272. Article 51A of the Indian Constitution is significant for environmental protection because it:
(A) Establishes the Central Pollution Control Board.
(B) Defines the protection of the natural environment as a fundamental duty of citizens.
(C) Prohibits the diversion of forest land.
(D) Grants the government power to declare national parks.

273. According to the passage, what was the primary legislative purpose of the Forest Conservation Act, 1980?
(A) To establish pollution control boards.
(B) To protect specific endangered species of wildlife.
(C) To create a fundamental duty for citizens to plant trees.
(D) To regulate the diversion of forest areas for other uses.

274. The Water Act of 1974 and the Air Act of 1981 are described as having a common structural outcome, which was the:
(A) Establishment of pollution control boards at central and state levels.
(B) Revision of the Indian Forest Act.
(C) Creation of constitutional duties for environmental protection.
(D) Amendment of the Wildlife Protection Act.

275. The passage suggests that the environmental laws of India, such as the Wildlife Protection Act and the Water Act, are:
(A) Independent of any constitutional foundation.
(B) Applicable only to non-forest areas.
(C) Legislative manifestations of the principles laid out in the Constitution.
(D) Subordinate to international environmental agreements.

Direction : Please read the following source carefully.

The Environmental (Protection) Act, 1986 (EPA) holds a unique and powerful position within India's environmental legal system. Enacted in the wake of the Bhopal Gas Tragedy, it was designed as an umbrella legislation. This characterization stems from its broad scope and the wide-ranging powers it confers upon the Central Government to take all such measures as it deems necessary for the purpose of protecting and improving the quality of the environment. The Act does not supersede earlier laws like the Water Act or Air Act but serves to fill gaps and provides a comprehensive framework for coordinating the activities of various central and state authorities established under previous laws. A key feature of the EPA is its provision for the Central Government to make rules to regulate environmental pollution. This enabling power has led to the notification of a suite of specific rules targeting different environmental problems. For instance, The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, and The Bio-Medical Waste Management Rules, 2016, all derive their legal authority from the EPA, 1986. These rules provide detailed procedures and standards for the handling, management, and disposal of specific categories of waste, demonstrating the Act's role in empowering targeted regulatory action.

Based on the above source, attempt the following five questions.

276. Why is the Environmental (Protection) Act, 1986, referred to as an umbrella legislation?
(A) Because it provides a broad, over arching framework and empowers the government to create specific rules.
(B) Because it exclusively deals with protection from rain and acid rain.
(C) Because it replaced and repealed all previous environmental acts like the Water and Air Acts.
(D) Because it was the first environmental law ever passed in India.

277. The passage indicates that rules such as The Plastic Waste Management Rules, 2016, and The Bio-Medical Waste Management Rules, 2016, derive their legal authority from:
(A) The Water (Prevention and Control of Pollution) Act, 1974.
(B) The constitutional provision of Article 48A.
(C) The Forest Conservation Act, 1980.
(D) The Environmental (Protection) Act, 1986.

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266. According to the described process, what is the immediate first step in a formal Risk Assessment?
(A) Defining the scenarios of exposure.
(B) Identifying the potential of an agent to cause harm.
(C) Quantifying the risk through characterization.
(D) Selecting options for risk management.

267. Which stage of Risk Assessment is responsible for integrating hazard and exposure data to estimate the likelihood and severity of adverse effects?
(A) Hazard Identification.
(B) Risk Characterization.
(C) Hazard Accounting.
(D) Scenarios of Exposure.

268. The paragraph implies a key distinction between Risk Assessment and Risk Management, where Risk Management is primarily concerned with:
(A) The process of deciding on and implementing control measures.
(B) The scientific identification of hazards.
(C) The quantification of exposure pathways.
(D) The initial characterization of the risk level.

269. The stage Scenarios of Exposure in a Risk Assessment would likely involve an analysis of which of the following?
(A) The inherent chemical properties of a hazardous substance.
(B) The economic cost of potential damage.
(C) The pathways and duration of contact between a population and a hazard.
(D) The selection of legal instruments to control the hazard.

270. What is the logical sequence of the first four stages of Risk Assessment as presented in the text?
(A) Hazard Accounting → Hazard Identification → Scenarios of Exposure → Risk Characterization.
(B) Scenarios of Exposure → Risk Characterization → Hazard Identification → Hazard Accounting.
(C) Risk Characterization → Risk Management → Hazard Identification → Hazard Accounting.
(D) Hazard Identification → Hazard Accounting → Scenarios of Exposure → Risk Characterization.

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Direction : Please read the following source carefully.

The framework for environmental law in India is anchored in its supreme legal document, the Constitution. Specific constitutional provisions lay the groundwork for environmental protection as a state responsibility and a citizen's duty. Article 48A, part of the Directive Principles of State Policy, directs the State to endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country. Complementing this is Article 51A, which enumerates the Fundamental Duties of citizens, including the duty to protect and improve the natural environment. Building upon this constitutional mandate, a comprehensive body of legislation has been enacted. Among the earliest and most significant of these is the Wildlife Protection Act, 1972, amended in 1991, which established a legal framework for the protection of wild animals, birds, and plants. To address deforestation, the Forest Conservation Act, 1980, was passed to regulate the diversion of forest land for non-forest purposes. Specific environmental media were also targeted, with the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, establishing central and state pollution control boards and providing a statutory basis for controlling pollution in water and air, respectively.

Based on the above source, attempt the following five questions.

271. What is the nature of the obligation placed upon the State by Article 48A of the Indian Constitution?
(A) A fundamental right enforceable by any citizen in court.
(B) A penal provision for punishing environmental offenders.
(C) A directive principle guiding the State to protect the environment.
(D) A guideline for international environmental treaties.

284. The Motor Vehicle Act, 1988, contributes to environmental protection primarily by:
(A) Including provisions to control pollution from vehicular emissions.
(B) Mandating Extended Producer Responsibility for car manufacturers.
(C) Regulating the disposal of used car batteries.
(D) Requiring insurance policies for accidents involving hazardous chemicals.

285. The passage illustrates that India's environmental legal system has evolved to:
(A) Rely on a single, all-encompassing law for all environmental issues.
(B) Focus exclusively on municipal solid waste.
(C) Create a series of highly specific rules for different waste streams and sectors.
(D) Prioritize liability and insurance over waste management.

Direction : Please read the following source carefully.

In addition to legally binding acts and rules, India's environmental governance is guided by national policies that articulate a long-term vision and strategy. These policies, while not typically enforceable in courts in the same manner as acts, provide a coherent framework for action and inform the direction of legislative and programmatic interventions. The National Forest Policy, 1988, represents a significant shift from a focus on commercial exploitation of forests to an emphasis on conservation, ecological balance, and meeting the needs of local populations. Its principal aim is to ensure environmental stability and maintain the ecological balance, including atmospheric equilibrium, which are vital for the sustenance of all life forms. A decade and a half later, the National Water Policy, 2002, was formulated to address the governance of water resources, promoting an integrated and multi-sectoral approach. It recognized water as a precious and finite resource and aimed to establish a standardized information system and plan for sustainable water resource development and management. The most comprehensive of these is the National Environmental Policy, 2006, which seeks to mainstream environmental concerns into all development activities. It builds upon earlier policies and legislation, articulating a broad vision for environmental protection and conservation in the context of sustainable development, and providing a guide to action for various stakeholders.

Based on the above source, attempt the following five questions.

286. What is the primary distinction drawn in the passage between national policies and legislative acts?
(A) Policies are international agreements, while acts are domestic laws.
(B) Policies focus only on forests, while acts cover water and air.
(C) Policies are created by state governments, while acts are created by the Central Government.
(D) Policies provide a strategic vision, while acts are legally enforceable mandates.

287. A major paradigm shift introduced by the National Forest Policy, 1988, was from:
(A) Conservation to commercial exploitation.
(B) Meeting local needs to prioritizing industrial demands.
(C) Commercial exploitation to conservation and ecological balance.
(D) A focus on wildlife to a focus on timber production.

288. The National Environmental Policy, 2006, is described as the most comprehensive because it:
(A) Exclusively addresses water resource management.
(B) Seeks to integrate environmental concerns into all developmental activities.
(C) Replaces all previous environmental laws and policies.
(D) Was the first environmental policy ever formulated in India.

289. According to the text, a key objective of the National Water Policy, 2002, was to:
(A) Privatize all water resources in the country.
(B) Focus solely on the prevention of water pollution.
(C) Repeal the Water (Prevention and Control of Pollution) Act, 1974.
(D) Promote an integrated and multi-sectoral approach to water management.

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290. What common purpose do the three described national policies share?
(A) To provide a guiding framework for sustainable and environmentally sound action.
(B) To establish legally binding emission standards.
(C) To detail the penal consequences for environmental violations.
(D) To create new regulatory bodies for enforcement.

Direction : Please read the following source carefully.

International cooperation is fundamental to addressing environmental challenges that transcend national borders. The journey of global environmental governance gained significant momentum with the Stockholm Conference on Human Environment in 1972, which was the first major UN conference on international environmental issues and laid the foundation for modern environmental diplomacy. A critical agreement addressing ozone layer depletion is the Montreal Protocol, 1987, which phased out the production of numerous substances responsible for ozone depletion. For the management of hazardous wastes, the Basel Convention (1989, 1992) was established to control the trans boundary movements of hazardous wastes and their disposal. The conservation and sustainable use of wetlands are the focus of the Ramsar Convention on Wetlands (1971), one of the earliest global conservation treaties. A watershed moment in international environmental law was the Earth Summit at Rio de Janeiro in 1992. This summit produced several landmark outcomes, including the Agenda-21, a comprehensive plan of action for sustainable development; the establishment of the Global Environmental Facility (GEF) to fund environmental projects; the Convention on Biological Diversity (CBD) for conserving biodiversity; and the United Nations Framework Convention on Climate Change (UNFCCC), which set the stage for future climate action.

Based on the above source, attempt the following five questions.

291. Which international agreement is specifically focused on controlling the trans boundary movement of hazardous wastes?
(A) The Montreal Protocol.
(B) The Ramsar Convention.
(C) The Basel Convention.
(D) The Convention on Biological Diversity.

292. The Earth Summit at Rio de Janeiro in 1992 resulted in which of the following outcomes?
(A) The creation of Agenda-21 as a plan for sustainable development.
(B) The phasing out of ozone-depleting substances.
(C) The establishment of the United Nations Environment Programme (UNEP).
(D) The first international conference on the human environment.

293. What is the primary focus of the Montreal Protocol, 1987?
(A) Protecting wetlands of international importance.
(B) Conserving biological diversity.
(C) Addressing climate change through emission reductions.
(D) Phasing out substances that deplete the ozone layer.

294. The passage identifies the Stockholm Conference of 1972 as a foundational event in:
(A) The creation of the Global Environmental Facility (GEF).
(B) The launch of global environmental diplomacy.
(C) The regulation of hazardous waste disposal.
(D) The conservation of biological diversity.

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295. According to the text, the Ramsar Convention (1971) is dedicated to the conservation of which specific type of ecosystem?
(A) Tropical rainforests.
(B) Coral reefs.
(C) Wetlands.
(D) Arid deserts.

Direction : Please read the following source carefully.

Following the 1992 Rio Earth Summit, the international community continued to build upon the framework of the UNFCCC to address climate change more concretely. This led to the adoption of the Kyoto Protocol in 1997, which established legally binding emission reduction

targets for developed countries and introduced innovative market-based mechanisms, including the Clean Development Mechanism (CDM). The CDM allowed developed countries to invest in emission-reduction projects in developing countries as an alternative way to meet their targets. Global environmental discourse continued through subsequent summits, such as the Earth Summit at Johannesburg in 2002 and RIO+20, which reviewed progress and renewed commitments to sustainable development. The Copenhagen Summit in 2009 attempted to create a successor agreement to the Kyoto Protocol but resulted in a non-binding accord. Parallel to these policy-making efforts, key international bodies play crucial roles. The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for assessing the science related to climate change. The United Nations Environment Programme (UNEP) acts as a global authority that sets the environmental agenda and promotes the coherent implementation of the environmental dimension of sustainable development. The International Geosphere-Biosphere Programme (IGBP) coordinates international research on global change.

Based on the above source, attempt the following five questions.

296. What was a key feature of the Kyoto Protocol, 1997, as mentioned in the passage?
(A) It established the Intergovernmental Panel on Climate Change (IPCC).
(B) It created voluntary emission goals for all countries.
(C) It was a non-binding accord that replaced the UNFCCC.
(D) It introduced the Clean Development Mechanism (CDM) and binding targets for developed nations.

297. What is the primary function of the Intergovernmental Panel on Climate Change (IPCC)?
(A) To act as the leading body for assessing the science of climate change.
(B) To fund environmental projects in developing countries.
(C) To enforce the emission reduction targets of the Kyoto Protocol.
(D) To coordinate international research on the geosphere and biosphere.

298. The Clean Development Mechanism (CDM) is described as a mechanism that allows:
(A) Developing countries to set their own binding emission targets.
(B) Developed countries to fund emission-reduction projects in developing countries.
(C) All countries to trade carbon credits freely without restrictions.
(D) UNEP to directly finance renewable energy installations.

299. According to the text, the role of the United Nations Environment Programme (UNEP) is to:
(A) Conduct scientific research on global change like the IGBP.
(B) Set the global environmental agenda and promote sustainable development.
(C) Assess and report on the science of climate change.
(D) Negotiate binding emission reduction targets for all nations.

300. How is the outcome of the Copenhagen Summit (2009) characterized in the passage?
(A) A non-binding accord.
(B) A legally binding successor to the Kyoto Protocol.
(C) The establishment of the Clean Development Mechanism.
(D) The successful review of the Millennium Development Goals.

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cradle-to-grave approach offers a comprehensive view of a project's extended environmental footprint. Similarly, cost-benefit analysis (CBA) is utilized to systematically quantify and compare the economic costs of a project against its benefits, often including the monetization of environmental impacts and mitigation expenses. The integration of environmental planning as a fundamental part of both EIA and the subsequent Environmental Audit ensures environmental considerations are not a one-time check but a continuous process. An Environmental Audit, conducted periodically after a project is operational, serves to verify compliance with the EMP and assess the effectiveness of mitigation measures, thereby creating a feedback loop for improved environmental performance and management.

Based on the above source, attempt the following five questions.

256. What is the primary focus of a Life-cycle analysis (LCA) as described in the text?
(A) To evaluate only the operational phase of a project.
(B) To assess environmental impacts across all stages of a product or project's existence.
(C) To focus exclusively on the economic costs and benefits.
(D) To analyze the legal compliance of a project during its construction.

257. The paragraph implies that an Environmental Audit is primarily conducted:
(A) Before the project construction begins.
(B) As a substitute for an EIA.
(C) Only if a major environmental disaster occurs.
(D) During the project's operational phase to ensure ongoing compliance.

258. How does cost-benefit analysis (CBA) contribute to the environmental assessment process?
(A) By monetizing and comparing the economic and environmental costs against the benefits.
(B) By replacing the need for an Environmental Management Plan.
(C) By providing a purely ecological evaluation of the project.
(D) By assessing the project's life-cycle from cradle to grave.

259. According to the paragraph, what is the role of environmental planning within the EIA and Environmental Audit framework?
(A) It is a one-time activity performed only before the EIA.
(B) It is an optional step that depends on the project's budget.
(C) It ensures environmental considerations are a continuous and integrated process.
(D) It exclusively deals with the legal aspects of environmental clearance.

260. The procedural review of an EIA for developmental projects serves to:
(A) Examine the EIA report for accuracy and completeness before approval.
(B) Conduct the initial Life-cycle analysis.
(C) Draft the project's cost-benefit analysis.
(D) Carry out the first Environmental Audit of the project.

Direction : Please read the following source carefully.

The formalization of environmental management within organizations is significantly guided by international standards and national schemes. The Environmental Management System (EMS) Standards, particularly the ISO 14000 series, provide a structured framework for organizations to manage their environmental responsibilities systematically. Adopting an EMS based on ISO 14000 helps an entity to identify and control its environmental impacts, improve its environmental performance through a cycle of planning, implementation, review, and continual improvement, and ensure compliance with environmental legislation. This voluntary system complements the regulatory requirements mandated by laws like the EIA Notification, 2006, and its subsequent amendments, which legally prescribe the process for obtaining environmental clearance for certain categories of projects in India. In addition to system-level standards, market-based instruments like eco-labeling schemes are employed. These schemes provide a way to inform consumers about the environmental credentials of products, thereby creating a market preference for goods that are demonstrably less harmful to the environment throughout their lifecycle. By

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8. (A) It primarily addresses the issue of global warming and carbon emissions.
The Montreal Protocol is an international treaty specifically designed to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances like chlorofluorocarbons. While these substances are also greenhouse gases, the primary focus of the protocol is ozone recovery rather than broader global warming or carbon emission reduction. Treaties like the Kyoto Protocol or the Paris Agreement are instead aimed at carbon emissions.

9. (B) 1, 2 and 3 only
An Environmental Management Plan is a crucial component of the impact assessment report, detailing specific measures for mitigating adverse environmental effects. It also includes strategies for monitoring environmental quality during the operational phase of a project to ensure compliance with standards. However, it is not a one-time plan implemented only before construction; rather, it is a dynamic document that continues throughout the entire operational life of the project.

10. (A) Evaluating environmental impacts of a product, process, or service from cradle to grave.
Life-cycle analysis involves a comprehensive evaluation of the environmental impacts associated with all stages of a product's life, from raw material extraction to final disposal. This cradle to grave approach accounts for energy consumption, emissions, and waste generation at every phase, including manufacturing, transportation, and usage. It provides a holistic view of environmental footprints, helping organizations identify opportunities for improvement and more sustainable resource management.

11. (D) To control the trans boundary movements of hazardous wastes and their disposal.
The Basel Convention is an international treaty adopted to regulate the trans boundary movement of hazardous wastes and ensure their environmentally sound management. It aims to protect human health and the environment by minimizing the generation of hazardous waste and preventing its transfer from developed to developing countries for disposal. The convention establishes strict criteria for the notification and movement of such materials across international borders to prevent dumping.

12. (A) P-3, Q-4, R-1, S-2
Environmental legislation in India follows a specific time line for enactment to address various ecological concerns effectively. The Wildlife Protection Act was established in 1972, followed by the Water Act in 1974. The Air Act was introduced in 1981, while the comprehensive Environmental Protection Act was enacted in 1986. These laws provide the regulatory framework for pollution control and the conservation of diverse natural resources across the nation.

13. (C) Convention on Biological Diversity (CBD)
The United Nations Conference on Environment and Development, also known as the Rio Summit of 1992, led to the establishment of the Convention on Biological Diversity. This landmark treaty aims to conserve biological diversity, promote the sustainable use of its components, and ensure the fair and equitable sharing of benefits arising from genetic resources. It represents a global commitment to protecting the variety of life on Earth for future generations.

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14. (D) Hazard Identification
Hazard Identification is the initial step in the risk assessment process, focusing on determining whether a particular agent or situation has the potential to cause harm. It involves characterizing the types of adverse effects a substance or activity might produce in human populations or ecosystems. By pinpointing potential sources of danger, this phase provides the foundational information necessary for subsequent steps like exposure assessment and risk characterization.

15. (A) 1, 2, 3, 4
Global environmental governance progressed through several landmark events starting with the Stockholm Conference in 1972 This was followed by the Rio Earth Summit in 1992, which produced Agenda 21 and the Convention on Biological Diversity. The World Summit on Sustainable Development took place in Johannesburg in 2002 to review progress. Finally, the Copenhagen Summit was held in 2009 to address climate

change mitigation and international carbon emission targets.

16. (B) Two categories (A and B), based on the potential impacts.
The Environmental Impact Assessment Notification of 2006 classifies developmental projects into two distinct categories based on their scale and potential impacts. Category A projects require mandatory prior environmental clearance from the central government ministry. Category B projects, which typically have lower impacts, are reviewed and cleared at the state level by specific impact assessment authorities. This categorization ensures that regulatory scrutiny is proportionate to the environmental significance of the project.

17. (B) Help consumers identify environmentally friendly products.
Eco-labeling schemes are voluntary market-based instruments designed to inform consumers about the environmental performance of specific products. By displaying a recognizable symbol or label, these schemes indicate that a product meets established environmental criteria throughout its life cycle. This helps consumers make informed purchasing decisions and encourages manufacturers to develop products with lower ecological impacts, promoting sustainable consumption and production patterns across various industrial sectors and consumer markets.

18. (A) Both A and R are true and R is the correct explanation of A.
The Forest Conservation Act of 1980 was specifically enacted to prevent the indiscriminate deforestation and the diversion of forest land for industrial or other non-forest uses. To achieve this objective, the Act mandates that any proposal for de-reservation or non-forest use of reserved lands must obtain prior approval from the Central Government. The requirement for central oversight ensures that local developmental pressures do not lead to unnecessary loss of forest cover.

19. (C) Radioactive wastes
The Bio-Medical Waste Management Rules of 2016 cover waste generated from hospitals, nursing homes, clinics, and veterinary institutions, including items from vaccination camps. However, radioactive wastes are specifically excluded from these rules as they are governed by different specialized regulations under the Atomic Energy Act. Proper segregation and disposal methods according to the nature of the waste are essential for protecting public health and preventing environmental contamination from hazardous biological materials.

20. (D) To protect and improve the natural environment and to have compassion for all living creatures.
Article 51A(g) of the Indian Constitution defines the fundamental duty of every citizen regarding the environment. It mandates that citizens must protect and improve the natural environment, including forests, lakes, rivers, and wildlife. Furthermore, it emphasizes having compassion for all living creatures. This constitutional obligation highlights the shared responsibility of individuals in preserving ecological integrity and promoting a sustainable relationship between human society and the diverse natural world.

21. (A) 1, 2 and 3 only
The Kyoto Protocol is an international agreement that extends the nineteen ninety-two Framework Convention on Climate Change. It was adopted in 1997 in Japan and commits parties to reduce greenhouse gas emissions based on scientific evidence of global warming. Notably, it follows the principle of common but differentiated responsibilities, meaning targets are not equal for all. Furthermore, the United States famously did not ratify the protocol during its initial commitment period.

22. (B) Environmental Audit
An Environmental Audit is a systematic and objective evaluation used to assess how well an organization's management systems are performing in relation to regulatory requirements. This documented process periodically reviews operational activities to ensure compliance with environmental laws and internal policies. Unlike impact assessments which predict future effects, audits focus on current and past performance to identify areas for improvement, reduce liabilities, and enhance the overall sustainability of existing industrial operations.

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23. (D) Developed countries to invest in emission-reduction projects in developing nations.
The Clean Development Mechanism is a flexible provision under the Kyoto Protocol that facilitates international cooperation in reducing greenhouse gas emissions. It allows developed countries with emission reduction commitments to invest in sustainable projects in developing nations. In return, the investing countries receive certified emission reduction credits that count toward their national targets. This mechanism promotes technology transfer to developing regions while providing a cost-effective way for developed nations to meet climate goals.

24. (A) 1974
The Water Prevention and Control of Pollution Act was enacted in 1974 to maintain and restore the wholesomeness of water resources in the country. This legislation established the Central and State Pollution Control Boards to regulate industrial effluents and sewage discharge. It marked a significant milestone in national environmental law by providing a structured legal framework to prevent water contamination and enforce compliance with prescribed standards for various water bodies and industrial sites.

25. (C) Rio de Janeiro, Brazil
The Rio+20 United Nations Conference on Sustainable Development was held in Rio de Janeiro, Brazil, in 2012 It marked the twentieth anniversary of the original Earth Summit held in the same city. The conference focused on two main themes: a green economy in the context of sustainable development and poverty eradication, and the institutional framework for sustainable development. It resulted in the political document titled The Future We Want, reaffirming global commitments.

26. (A) The Batteries (Management and Handling) Rules
In 2016, the Indian government notified several comprehensive waste management regulations, including the Plastic Waste Management Rules, the e-waste Management Rules, and the Solid Waste Management Rules. These were designed to update and strengthen existing protocols for diverse waste streams. However, the Batteries Management and Handling Rules were originally notified in 2001 and have been amended at different times, rather than being part of the specific set of rules promulgated in 2016.

27. (B) P-4, Q-3, R-1, S-2
International environmental agreements focus on specific ecological challenges to ensure coordinated global action. The Ramsar Convention is dedicated to the conservation of wetlands, while the Montreal Protocol targets the protection of the ozone layer. The Basel Convention regulates the trans boundary movement of hazardous wastes. Finally, the Kyoto Protocol is an extension of the climate change convention focusing on the reduction of greenhouse gas emissions to mitigate the impacts of global warming.

28. (B) Estimating the incidence and severity of adverse effects likely to occur in a population due to exposure.
Risk Characterization is the final phase of the scientific risk assessment process. It involves integrating data from hazard identification, dose-response assessment, and exposure assessment to estimate the overall probability and severity of adverse effects in a target population. This step summarizes the nature and magnitude of risks, including any uncertainties, providing a clear basis for decision-makers to implement appropriate risk management strategies and regulatory controls to protect public health.

29. (C) Statement I is true, but Statement II is false.
Cost-benefit analysis in environmental assessments attempts to quantify the economic costs and benefits of a project in monetary terms to facilitate decision-making. While financial aspects are straightforward, many environmental impacts like the loss of biodiversity or changes in aesthetic value are extremely difficult to quantify accurately in money. Therefore, while the method aims for monetary quantification, it is not always easy or precise for all ecological and cultural values affected by projects.

30. (D) Identifying and cataloging types and quantities of hazardous materials at a facility.
Hazard Accounting is a specific process within risk assessment that involves identifying and cataloging the various types and quantities of hazardous materials present at a facility. It creates a formal record of substances that could

NODIA

nations, the programme helped improve our understanding of how human activities influence the planet's life-support systems, providing essential data for international environmental assessments and policy development regarding global sustainability.

74. (B) 1, 2, 4, 3`
International environmental agreements were adopted progressively to address emerging global issues. The Montreal Protocol on ozone protection was signed in 1987, followed by the Basel Convention on hazardous waste in 1989. The landmark Rio Earth Summit took place in 1992, producing Agenda 21 and several key conventions. Finally, the Kyoto Protocol, which set binding targets for greenhouse gas reductions, was adopted in 1997. This sequence reflects the evolving global focus from chemical pollution to sustainable development and climate change.

75. (D) Waste generator
Under the Solid Waste Management Rules of 2016, the primary responsibility for segregating waste into biodegradable, non-biodegradable, and domestic hazardous categories lies with the waste generator. This includes households, commercial establishments, and institutions. Segregation at the source is critical for efficient waste management, as it facilitates recycling and composting while reducing the volume of waste sent to landfills. By involving citizens directly, the rules promote a more sustainable and participatory approach to managing municipal solid waste.

76. (B) United Nations Framework Convention on Climate Change (UNFCCC)
The Conference of the Parties is the supreme decision-making body of the United Nations Framework Convention on Climate Change. It brings together all the countries that are parties to the convention to review its implementation and negotiate new agreements to address climate change. COPs are held annually and serve as the primary forum for international climate negotiations, where major decisions such as the adoption of the Kyoto Protocol and the Paris Agreement have been made to guide global climate action.

77. (A) P-3, Q-2, R-1, S-4
Indian environmental policies and rules have been established over several decades to address various ecological concerns. The National Forest Policy was enacted in 1988, while the National Environmental Policy was introduced in 2006. More recently, in 2016, the government notified comprehensive new regulations for both Solid Waste Management and Bio-Medical Waste Management. This timeline reflects the progressive development of the national regulatory framework to ensure the sustainable management of resources and the protection of public health.

78. (D) Every entity involved in electronic equipment manufacturing and sales.
The e-waste Management Rules of 2016 have a wide scope, applying to almost every entity involved in the lifecycle of electrical and electronic equipment. This includes manufacturers, producers, importers, dealers, e-retailers, and collection centers, as well as bulk consumers and recyclers. By covering the entire supply chain, the rules ensure a comprehensive approach to the collection and environmentally sound management of electronic waste, preventing hazardous materials from entering the environment and promoting the recovery of valuable resources.

79. (A) Both Statement I and Statement II are true.
An Environmental Impact Statement is a comprehensive document that describes the potential environmental effects, both positive and negative, of a proposed project. Within this statement, various methodologies are used to evaluate the significance of these impacts. Cost-benefit analysis is one such methodology often included to quantify environmental costs and benefits in monetary terms. By integrating these tools, the statement provides decision-makers with a detailed assessment of the project's overall sustainability and its potential impact on the environment.

80. (B) Segregate construction and demolition waste and deposit it at collection centers.
The Construction and Demolition Waste Management Rules of 2016 impose specific duties on waste generators to ensure responsible disposal. Generators are required to segregate waste into different streams, such as concrete,

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promoting transparency and social acceptability of developmental activities.

38. (A) 3, 2, 1, 4`
India's environmental legal framework was built progressively over several decades. The Water Act was the first major pollution control law enacted in 1974. This was followed by the Air Act in 1981 to address atmospheric pollution. The comprehensive Environment Protection Act was subsequently passed in 1986 in the wake of industrial disasters. Finally, the Biological Diversity Act was enacted in 2002 to meet international obligations regarding the conservation of diverse biological resources.

39. (D) Regulating the transit of forest produce and levying duties on timber.
The Indian Forest Act is primarily focused on the administrative and management aspects of forests. It provides the legal framework for the transit of forest produce, the levying of duties on timber, and the regulation of various forest-related activities. While later laws emphasize conservation and biodiversity, this Act remains central to the state's control over forest resources and the commercial aspects of timber and other forest products within the national territory.

40. (A) Intergovernmental Panel on Climate Change (IPCC)
The Intergovernmental Panel on Climate Change is the leading international body for the assessment of climate change science. Established by the United Nations and the World Meteorological Organization, it reviews and synthesizes scientific data from around the world to provide policymakers with regular reports. These assessments cover the physical science of climate change, its potential impacts, and strategies for adaptation and mitigation, serving as the scientific basis for international climate negotiations and policies.

41. (A) 1 and 2 only
The Coastal Regulation Zone Notification of 1991 was introduced to protect and conserve the fragile coastal environment. It classifies coastal areas into different zones based on their ecological sensitivity and developmental needs. While it restricts certain activities to prevent degradation, it does not prohibit all developmental activities. The notification has undergone several amendments since its inception to address evolving coastal challenges and balancing environmental protection with the sustainable development of coastal communities and industrial infrastructure.

42. (A) Environmental Management Plan (EMP)
An Environmental Management Plan is a detailed document that outlines the specific procedures an organization will follow to manage its environmental impacts. It includes mitigation measures for pollution, waste handling protocols, and emergency response plans. Furthermore, it establishes a schedule for monitoring environmental indicators like air and water quality. By providing a clear roadmap for environmental compliance and performance, the plan ensures that the commitments made during the assessment phase are effectively implemented during operations.

43. (D) It was the first major international environmental conference and led to the creation of UNEP.
The 1972 Stockholm Conference on the Human Environment was a watershed moment in global environmental history. It was the first major international gathering to discuss the relationship between humans and the environment on a global scale. A significant outcome of this conference was the creation of the United Nations Environment Programme, which became the leading global environmental authority. The event also established principles for ecological management and paved the way for future international treaties and cooperation.

44. (C) P-3, Q-4, R-1, S-2
India's waste management framework categorizes materials into specific streams to ensure specialized handling and disposal. Household and street waste are managed under the Solid Waste Rules, while discarded electronics fall under the e-waste Rules. Hospital waste requires strict sterilization and disposal according to the Bio-Medical Waste Rules. Finally, materials from building projects are governed by the Construction and Demolition Waste Rules. This systematic approach ensures that different types of waste are treated appropriately.

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Conservation Act. Protecting the environment is established as a fundamental duty under Article 51A. Finally, the Environment Protection Act provides the framework for managing hazardous wastes through specialized rules.

60. (B) Climate change mitigation and adaptation
The Copenhagen Summit of 2009 was a major international conference focused on global climate change. It aimed to establish a new international agreement to succeed the Kyoto Protocol and address greenhouse gas emission reductions. While it did not result in a legally binding treaty, it produced the Copenhagen Accord, which highlighted the need for climate change mitigation and adaptation measures. The summit underscored the challenges of reaching international consensus on complex environmental issues like global warming.

61. (C) Regulate the activities related to certain hazardous chemicals to prevent major accidents.
The Manufacture, Storage and Import of Hazardous Chemical Rules were amended in 2000 to improve industrial safety and prevent major accidents. These rules mandate that facilities handling specific hazardous chemicals must implement strict safety measures, prepare emergency plans, and provide information to authorities and the public. By regulating how these chemicals are managed throughout their lifecycle, the rules aim to minimize the risk of industrial disasters and protect the surrounding communities and the environment.

62. (D) It provides for equitable sharing of benefits arising from the use of biological resources and associated traditional knowledge.
A key feature of the Biological Diversity Act of 2002 is its emphasis on equitable benefit sharing. This provision ensures that when biological resources or associated traditional knowledge are used for commercial or research purposes, the benefits derived are shared fairly with the local communities and stakeholders who have conserved these resources. This mechanism promotes social justice and provides incentives for biodiversity conservation, recognizing the traditional roles of indigenous populations in maintaining the country's natural heritage.

63. (A) 1, 2, 3, 4 and 5 are all correct and in the right order.
The environmental impact assessment process follows a logical sequence of stages to ensure thorough evaluation. It begins with screening to determine if an assessment is necessary, followed by scoping to identify key issues. Then, impact analysis predicts the magnitude of effects, and mitigation measures are proposed to reduce negative impacts. Finally, the findings are presented in an impact statement. This structured approach ensures that all environmental aspects are systematically considered before a project is approved.

64. (B) Producer/Importer
The Batteries Management and Handling Rules establish the principle of extended producer responsibility for the management of used lead-acid batteries. This means that producers and importers are primarily responsible for setting up collection centers and ensuring that discarded batteries are safely recycled. By placing this responsibility on the manufacturers and importers, the rules aim to create a closed-loop system that prevents hazardous lead from contaminating the environment and ensures the sustainable recovery of valuable materials.

65. (B) It is only applicable to air and water pollution.
The Environment Protection Act of 1986 is an umbrella legislation that provides the central government with broad powers to address various environmental issues. It is not limited to air and water pollution; rather, it allows for the regulation of hazardous substances, waste management, and the setting of general environmental quality standards. Enacted following the Bhopal Gas Tragedy, the Act serves as a comprehensive legal framework for environmental protection, filling gaps left by earlier, more specialized laws.

66. (A) Strategic Environmental Assessment
Strategic Environmental Assessment is a systematic process used to evaluate the environmental consequences of proposed policies, plans, or programs. Unlike project-specific assessments, it occurs at a higher level of decision-making, allowing for the integration of environmental considerations into the very foundations of development strategies. By assessing the broader implications of sectoral

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Agenda 21 is a comprehensive and voluntary action plan for sustainable development adopted by over 170 countries at the 1992 Earth Summit. It provides a blueprint for global, national, and local actions to address various environmental and developmental challenges in the twenty-first century. The plan covers areas such as poverty eradication, resource conservation, and social equity, emphasizing the need for international cooperation and local community involvement to achieve a sustainable future for the entire planet.

53. (A) Both A and R are true and R is the correct explanation of A.
The Environmental Protection Act of 1986 is considered an umbrella legislation because it provides a broad and comprehensive framework for environmental management. It grants the central government the power to coordinate the activities of various authorities established under earlier, more specific laws like the Water and Air Acts. This structure allows the government to fill gaps in existing legislation and take necessary measures to protect and improve environmental quality in a holistic and integrated manner.

54. (B) Agricultural Area
The Noise Pollution Regulation and Control Rules of 2000 establish ambient noise level standards for different types of areas to protect public health and well-being. The specified classifications include industrial areas, commercial areas, residential areas, and silence zones. While agricultural activities occur widely, there is no separate standard classification for agricultural areas under these specific noise rules. The standards for day and night vary across these categories to account for different land uses and human activities.

55. (D) Iran
The Convention on Wetlands, commonly known as the Ramsar Convention, was signed in 1971 in the city of Ramsar, Iran. It is an international treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It was the first modern global intergovernmental treaty on the environment, recognizing the vital ecological functions of wetlands as well as their economic, cultural, scientific, and recreational value.

56. (D) A precise chronological order cannot be determined as all were notified in the same year.
In 2016, the Indian Ministry of Environment, Forest and Climate Change undertook a major regulatory update by notifying several sets of waste management rules. These rules covered solid waste, plastic waste, bio-medical waste, e-waste, hazardous waste, and construction and demolition waste. Because all these comprehensive rules were promulgated during the same year as part of a synchronized policy initiative, determining a precise chronological sequence based solely on the year of notification is not feasible.

57. (C) A shift from a purely engineering-centric approach to a more holistic and river basin-oriented approach.
The National Water Policy of 2002 marked a significant evolution in water resource management in India. It emphasizes a shift from traditional engineering-focused solutions toward a more holistic, river basin-oriented approach. The policy recognizes water as a scarce and precious resource, prioritizing its use for drinking and advocating for sustainable management through community participation. It also highlights the need for integrating environmental concerns and balancing the needs of different sectors within each hydrological unit.

58. (A) Risk Management
Risk Management is the final and decisive step in the risk assessment and control process. It involves evaluating the results of the scientific risk assessment to make informed decisions about which risks require intervention. This phase includes identifying and implementing specific strategies, such as regulatory actions or engineering controls, to mitigate or eliminate identified hazards. By balancing scientific findings with social and economic factors, risk management ensures that effective measures are taken to protect human health.

59. (A) P-4, Q-1, R-3, S-2
Indian environmental law is comprised of various acts and constitutional duties that address specific ecological issues. The inclusion of noise as a pollutant occurred through an amendment to the Air Act. The diversion of forest land for non-forest purposes is regulated by the Forest

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45. (C) Implement the obligations of the Convention on Biological Diversity (CBD).
The Biological Diversity Act of 2002 was enacted in India to fulfill the obligations under the international Convention on Biological Diversity. The Act focuses on the conservation of biological resources, their sustainable use, and the fair and equitable sharing of benefits arising from the use of genetic resources and traditional knowledge. It established a decentralized structure to regulate access to biological materials, ensuring that the country's diverse natural heritage is protected and utilized responsibly.

46. (D) Checklists and Matrices
Impact assessment methodologies are structured tools used to identify and evaluate the potential environmental consequences of projects. Checklists and matrices are classic examples of these methodologies. Checklists provide a comprehensive list of environmental factors to consider, while matrices allow for the systematic cross-referencing of project activities with their potential impacts on different environmental components. These tools help ensure that all relevant impacts are considered during the assessment process, providing a clear visual representation of findings.

47. (A) Setting standards for vehicular emissions and noise.
The Motor Vehicle Act of 1988 includes specific provisions aimed at environmental protection by regulating the pollutants emitted by vehicles. It empowers the government to set standards for vehicular emissions and noise levels, ensuring that motor vehicles do not excessively contaminate the air or contribute to noise pollution. Regular checks and certification processes are mandated to ensure that vehicles comply with these environmental standards, reflecting the integration of ecological concerns into national transportation regulations.

48. (D) Statement I is false, but Statement II is true.
Environmental planning is not a separate or isolated activity; rather, it is an essential and integral part of the overall assessment and auditing processes. It guides the strategy for achieving sustainable development by ensuring that environmental considerations are woven into project design and organizational management. Effective planning uses the findings from impact assessments and audits to create long-term roadmaps for resource conservation and pollution prevention, rather than being conducted after these processes are already completed.

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49. (B) Describing the pathways by which individuals or the environment might come into contact with a hazard.
Scenarios of exposure in risk assessment involve a detailed analysis of the pathways through which a hazard might reach a receptor, such as a human population or an ecosystem. This includes identifying the sources of release, the media through which the hazard travels, and the points of contact. By understanding these pathways, researchers can estimate how much contact occurs and under what conditions, which is crucial for determining the overall risk posed by a substance.

50. (A) Meeting the basic needs of rural and tribal populations for fuel, fodder, and forest produce.
The National Forest Policy of 1988 shifted the focus of forest management from commercial timber extraction to ecological stability and meeting the needs of local communities. A primary objective is to ensure that rural and tribal populations have access to essential resources like fuel, fodder, and small timber for their livelihoods. This people-centric approach recognizes the traditional rights of forest-dependent communities and emphasizes their involvement in the protection and sustainable management of forest resources.

51. (A) 1 and 3 only
The ISO 14000 series consists of voluntary international standards focused on environmental management systems. These standards guide organizations on how to minimize their harmful impacts on the environment and continuously improve their environmental performance. While many companies seek certification for competitive advantage, it is not a mandatory legal requirement for all industries in India. Furthermore, these are management system standards that address organizational processes rather than specific product performance or safety specifications for individual items.

52. (D) A comprehensive plan of action for global sustainable development.

or regional policies, this tool helps ensure that sustainable development goals are prioritized and that cumulative environmental effects are addressed early in the planning process.

67. (A) Both A and R are true and R is the correct explanation of A.
Life-cycle analysis is a complex and data-intensive process because it aims to provide a holistic view of a product's environmental impact. To be effective, it must account for every input and output throughout the entire lifecycle, including raw material extraction, manufacturing, transportation, use, and final disposal. Gathering accurate data for each of these stages across various geographical locations and industries makes the process challenging, but this comprehensive approach is necessary for identifying true environmental footprints.

68. (D) Provide for the protection of specified plants and to regulate trade in them.
The 1991 amendment to the Wildlife Protection Act was significant because it expanded the legal protection beyond animals to include specified plant species. This amendment introduced provisions to protect rare and endangered plants and regulate their trade, recognizing their critical role in ecosystems. By including plants within the legal framework, the government strengthened its ability to conserve biological diversity as a whole and prevent the illegal exploitation of the country's diverse and vulnerable flora.

69. (C) UNEP
The United Nations Environment Programme is the leading global environmental authority within the United Nations system. It is responsible for setting the global environmental agenda, promoting the coherent implementation of the environmental dimension of sustainable development, and serving as an authoritative advocate for the global environment. UNEP coordinates international environmental efforts, provides scientific assessments, and assists countries in developing policies and legislation to address environmental challenges like climate change, pollution, and biodiversity loss.

70. (B) The process of analyzing, evaluating, and making decisions to control and reduce identified risks.
Risk Management is a decision-making process that uses the results of risk assessments to determine the best actions for controlling and reducing identified risks. It involves evaluating various mitigation options, taking into account technical, social, economic, and political factors. By selecting and implementing appropriate control measures, such as engineering changes, safety protocols, or regulatory requirements, risk management aims to protect human health and the environment from the harmful effects of hazardous substances or activities.

71. (A) 1 and 4 only
The principle of Extended Producer Responsibility is a key feature of the Plastic Waste Management and e-waste Management Rules of 2016. It mandates that producers, importers, and brand owners are responsible for the collection and environmentally sound management of their products at the end of their useful lives. This principle encourages manufacturers to design more sustainable products and ensures that the financial and physical burden of waste management is shared by those who put the products on the market.

72. (A) Conservation of forest land and preventing its diversion for non-forest purposes.
The Forest Conservation Act of 1980 is primarily concerned with preserving the country's forest cover. Its central objective is to regulate and limit the diversion of forest land for non-forest purposes, such as mining, industry, or infrastructure projects. The Act mandates that any such diversion must receive prior approval from the Central Government, ensuring that forest conservation is prioritized and that developmental needs are balanced against the essential ecological services provided by healthy forest ecosystems.

73. (C) International Geosphere-Biosphere Programme
IGBP stands for the International Geosphere-Biosphere Programme, which was a major international research initiative focused on global environmental change. It aimed to provide scientific knowledge about the interactive physical, chemical, and biological processes that regulate the Earth's system. By coordinating research across different disciplines and

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potentially cause harm if released. This detailed inventory is essential for understanding the scale of potential risks, planning for emergency responses, and ensuring that appropriate safety measures are in place to handle hazardous chemicals and materials securely.

31. (B) 1, 2, 3 and 4
The Wildlife Protection Act of 1972 is a comprehensive law that protects wild animals, birds, and plants across the country. It establishes several schedules that prohibit the hunting of various species and provides for the creation of protected areas like National Parks and Wildlife Sanctuaries. The Act has undergone various amendments, including a significant one in 1991, to strengthen enforcement and expand its scope, ensuring the long-term conservation of India's diverse biological heritage.

32. (B) Both CBD and UNFCCC, among others.
The Global Environmental Facility serves as an international financial mechanism that provides grants and concessional funding for environmental projects in developing countries. It supports the implementation of several major international conventions, including the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. By assisting nations in meeting their obligations under these treaties, the facility plays a critical role in addressing global environmental challenges like biodiversity loss and climate change.

33. (B) Ensuring all developmental projects are exempted from formal environmental scrutiny.
The National Environmental Policy of 2006 aims to integrate environmental concerns into all development plans and projects to ensure sustainable growth. Its objectives include conserving critical resources and ensuring livelihood security for poor communities dependent on nature. However, it does not aim to exempt developmental projects from scrutiny; instead, it emphasizes robust assessment processes to ensure that all projects are evaluated for their potential environmental impacts before they are granted approval for implementation.

34. (A) Immediate relief to persons affected by accidents while handling hazardous substances.
The Public Liability Insurance Act of 1991 was enacted to provide immediate financial relief to victims of accidents occurring during the handling of hazardous substances. It operates on the principle of no-fault liability, meaning compensation can be provided without proving negligence on the part of the owner. The Act mandates that owners of facilities handling such materials must take out insurance policies to cover potential liabilities, ensuring swift support for affected individuals and families.

35. (A) Both A and R are true and R is the correct explanation of A.
The Air Prevention and Control of Pollution Act was originally enacted in 1981 and underwent a significant amendment in 1987. This amendment was crucial because it expanded the definition of air pollution to include noise as a pollutant. By incorporating noise within the legal framework of the Air Act, the government empowered pollution control boards to set standards and regulate noise levels, recognizing its harmful effects on human health and the natural environment.

36. (D) 2000
The United Nations Millennium Summit was held in the year 2000, leading to the adoption of the Millennium Development Goals. These eight time-bound targets aimed to address various global issues, including poverty, education, and health. Goal seven specifically focused on ensuring environmental sustainability. The summit represented a unified global commitment to improve living standards and protect the environment, setting the stage for subsequent sustainable development initiatives and the later Sustainable Development Goals.

37. (C) To identify concerns of affected persons and incorporate them into the project design.
Public consultation is a mandatory step in the environmental impact assessment process designed to involve stakeholders and local communities in decision-making. Its primary purpose is to identify the concerns of people who might be adversely affected by a project. By gathering local knowledge and feedback, authorities can ensure that potential impacts are better understood and that mitigation measures are incorporated into the project design,

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soil, and wood, and deposit it at designated collection centers or processing facilities. This prevents construction debris from being mixed with municipal waste or dumped illegally in water bodies. By promoting segregation and recycling, the rules help reduce the environmental impact of urban development and conserve natural resources.

81. (B) The evolving discourse on environment and the promotion of global sustainable development.
Major United Nations conferences, from Stockholm in 1972 to Rio+20 in 2012, are connected by a common theme: the evolving international discourse on the environment and the promotion of sustainable development. These summits have progressively shaped global policy, moving from a focus on specific pollution issues to a holistic approach that integrates economic growth, social equity, and environmental protection. This ongoing dialogue has established the principles and goals that guide international efforts toward a more sustainable and resilient future.

82. (A) EIA is a tool for future prediction, while an audit is a tool for checking past and present performance.
The fundamental difference between an environmental assessment and an audit lies in their temporal focus. An impact assessment is a predictive tool used during the planning stages of a proposed project to identify and mitigate future environmental consequences. In contrast, an environmental audit is a retrospective tool used to evaluate the environmental performance and regulatory compliance of an existing facility. While assessment aims for prevention, auditing focuses on monitoring, verification, and improving the current operational practices of a project.

83. (C) The Water (Prevention and Control of Pollution) Act, 1974
The Water Act of 1974 provided the legal basis for the establishment of the Central Pollution Control Board and the various State Pollution Control Boards. These statutory bodies were created to enforce environmental laws, set standards for effluents and emissions, and monitor environmental quality across the country. This institutional framework was a major step in building national capacity for environmental regulation and remains the backbone of the country's pollution control and enforcement system for water, air, and other resources.

84. (A) Both A and R are true and R is the correct explanation of A.
The Basel Convention was adopted to address the serious problem of hazardous waste being shipped from developed to developing countries for disposal. This practice often resulted in toxic colonialism, where waste was dumped in nations that lacked the capacity to manage it safely, often without their full consent or knowledge. The convention establishes strict controls and notification procedures for the transboundary movement of such wastes, ensuring that they are managed in an environmentally sound manner at their source.

85. (C) To promote economic growth at the expense of environmental quality.
The National Environmental Policy of 2006 seeks to achieve a balance between developmental needs and environmental conservation. Its aims include the conservation of critical resources, ensuring equitable access to those resources, and distributing the benefits of conservation fairly. It explicitly rejects the idea that economic growth should occur at the expense of environmental quality. Instead, the policy advocates for the integration of environmental concerns into all development plans to ensure that growth is sustainable and does not compromise future generations.

86. (B) Environmental considerations are integrated into core project design from the beginning.
Integrating environmental planning into assessments and audits means that ecological considerations are not treated as an afterthought. Instead, they are incorporated into the core project design from the earliest stages. This proactive approach ensures that potential impacts are identified and addressed during the planning phase, leading to more sustainable and environmentally friendly project outcomes. By making environmental concerns a central part of the decision-making process, organizations can minimize their ecological footprint and improve their overall environmental performance and compliance.

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87. (D) The Batteries (Management and Handling) Rules - 2016
While many waste management rules in India were significantly updated or newly notified in 2016, the Batteries Management and Handling Rules were not part of that specific group. Those rules were originally notified in 2001 and have been amended at different times. The other rules mentioned, including those for plastic, bio-medical, and e-waste, were all part of the comprehensive regulatory update undertaken by the Ministry of Environment in 2016 to strengthen the national framework for waste management and resource recovery.

88. (A) The World Summit on Sustainable Development
The Earth Summit held in Johannesburg in 2002 is officially known as the World Summit on Sustainable Development. Ten years after the first Earth Summit in Rio, this conference aimed to review the progress made in implementing Agenda 21 and to revitalize global commitment to sustainable development. The summit produced the Johannesburg Plan of Implementation, which focused on practical actions to address poverty, improve sanitation, and promote sustainable consumption and production patterns, highlighting the interlinked nature of social and environmental challenges.

89. (B) 1, 3 and 4 only
Cost-benefit analysis is a widely used tool in environmental assessments that attempts to place monetary values on all project costs and benefits. A project is typically considered economically viable if its benefit-cost ratio is greater than one. However, the method is not completely value-free, as it involves making choices about which impacts to include and how to value them. It is frequently criticized for the difficulty in accurately monetizing intangible environmental goods, such as ecosystem services or cultural heritage values.

90. (A) Brought noise pollution under the definition of air pollution.
The 1987 amendment to the Air Act was a landmark change in Indian environmental law because it expanded the scope of the Act to include noise as an air pollutant. This recognition of the harmful effects of excessive noise on human health and the environment allowed pollution control boards to set ambient noise standards and regulate noise levels from various sources. The amendment reflected an increasing awareness of noise as a significant environmental problem that required formal legal control and monitoring.

91. (D) Environmental Management System
ISO 14001 is an internationally recognized standard that specifies the requirements for an effective environmental management system. It provides a framework that organizations can follow to identify, manage, monitor, and control their environmental issues in a holistic manner. By implementing ISO 14001, organizations can improve their environmental performance, ensure compliance with environmental laws, and demonstrate their commitment to sustainability to stakeholders. It is a process-oriented standard that focuses on continuous improvement and the prevention of pollution.

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92. (B) Take out an insurance policy to cover liability to third parties from accidents.
The Public Liability Insurance Act of 1991 mandates that owners of enterprises handling hazardous substances must take out insurance policies to cover potential liabilities arising from accidents. This ensures that immediate financial relief can be provided to third parties, such as local residents or the environment, in the event of a chemical leak or other mishap. The Act is based on the principle of no-fault liability, meaning that compensation is provided without the need to prove negligence, ensuring swift support for victims.

93. (C) Agenda 21
One of the most significant outcomes of the 1992 Earth Summit in Rio de Janeiro was the adoption of Agenda 21. This comprehensive and voluntary plan of action provides a blueprint for achieving sustainable development at global, national, and local levels in the twenty-first century. It covers a wide range of issues, including poverty, resource management, and social equity, and emphasizes the role of international cooperation and local participation. Agenda 21 continues to be a foundational document for global sustainability initiatives and policies.

94. (A) Both Statement I and Statement II are true.

The Environmental Impact Assessment Notification of 2006 mandates that certain categories of developmental projects must obtain prior environmental clearance before they can begin construction or operation. The primary purpose of this mandatory requirement is to ensure that environmental concerns are systematically integrated into the project approval process. By evaluating potential impacts beforehand, authorities can ensure that projects are designed and executed in a way that minimizes environmental harm and promotes sustainable development, balancing economic growth with ecological protection.

95. (A) Who or what is exposed, and through what pathway?
In the context of risk assessment, scenarios of exposure analysis are used to identify the individuals or environmental components that might come into contact with a hazard and the specific pathways through which that contact occurs. This involves analyzing the sources of the hazard, the media through which it travels, and the potential routes of exposure, such as inhalation or ingestion. By answering these questions, researchers can estimate the magnitude and duration of exposure, which is essential for determining overall risk.

96. (B) P-3, Q-4, R-2, S-1`
International environmental bodies have distinct roles in global governance. The Intergovernmental Panel on Climate Change assesses climate science, while the United Nations Environment Programme sets the global environmental agenda. The Global Environment Facility provides funding for projects in developing countries to help them meet environmental goals. Finally, the International Geosphere-Biosphere Programme coordinates international research on global change. Together, these organizations provide the scientific, financial, and policy framework needed to address complex global environmental challenges and promote sustainable development.

97. (B) National Environmental Policy, 2006
The National Environmental Policy of 2006 explicitly adopts the polluter pays principle as a core guiding principle for environmental management in India. This principle states that those who cause environmental pollution should bear the costs of managing it and repairing any damage done. By internalizing environmental costs, the policy encourages industries and individuals to adopt cleaner technologies and practices. This approach promotes both environmental protection and economic efficiency, ensuring that the burden of pollution is not shifted to the public or the environment.

98. (A) Using forest land for non-forest purposes like mining or industry.
The Forest Conservation Act of 1980 regulates activities that involve the diversion of forest land for non-forest uses, such as mining, industrial development, or large-scale infrastructure projects. The Act mandates that any such use of forest land requires prior approval from the central government, ensuring that the impact on forest cover is carefully considered and that compensatory measures are implemented. This centralized oversight is crucial for maintaining the country's forest ecosystems and preventing indiscriminate deforestation for short-term economic gains.

99. (A) 3, 1, 2, 4`
Global environmental summits have occurred periodically to address pressing ecological issues. The Rio+20 conference took place in 2012, followed by the Copenhagen Summit in 2009. The World Summit on Sustainable Development was held in Johannesburg in 2002 Finally, the landmark Earth Summit in Rio de Janeiro occurred in 1992 Arranging these in reverse chronological order shows the progression of international efforts to address climate change and sustainable development, with each summit building on the commitments and lessons of its predecessors.

100. (D) The project requires clearance from the State Level Environmental Impact Assessment Authority (SEIAA).
Under the 2006 impact assessment notification, developmental projects are categorized based on their potential environmental impacts. Category B projects are those that typically have lower impacts and are reviewed at the state level. These projects must obtain prior environmental clearance from the State Level Environmental Impact Assessment Authority. This decentralized

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The legal obligation for a producer to manage the collection and recycling of their products at the end of their useful life is known as extended producer responsibility. This principle shifts the financial and physical burden of waste management from local governments and consumers to the manufacturers. By holding producers responsible for the entire lifecycle of their products, it encourages them to design items that are more durable, easier to recycle, and less hazardous. This approach is a key component of modern waste management strategies for electronics and other consumer goods.

141. (D) Earth Summit at Rio de Janeiro (1992)
The United Nations Framework Convention on Climate Change was one of the major outcomes of the 1992 Earth Summit in Rio de Janeiro. This landmark international treaty established a framework for global cooperation to address climate change by stabilizing greenhouse gas concentrations in the atmosphere. The convention paved the way for subsequent agreements like the Kyoto Protocol and the Paris Agreement. Its adoption at the Rio Summit marked a significant step in the global recognition of climate change as a critical environmental and developmental challenge requiring coordinated international action.

142. (A) P-2, Q-1, R-4, S-3
The environmental impact assessment process involves several key stages with distinct meanings. Screening is the initial step to determine if an assessment is needed for a particular project. Scoping identifies the most important issues and impacts that should be studied in detail. Mitigation involves proposing measures to reduce or avoid adverse effects, while monitoring is used to check the actual impacts of the project after implementation. Together, these stages provide a structured and comprehensive approach to evaluating and managing the environmental consequences of developmental activities.

143. (A) Constructing a new thermal power plant
Under the 2006 impact assessment notification, large-scale industrial projects like thermal power plants are mandatory candidates for prior environmental clearance. These projects have the potential for significant environmental impacts on air and water quality, as well as local ecosystems. The requirement for clearance ensures that these impacts are thoroughly evaluated and that appropriate mitigation measures are included in the project design. In contrast, everyday activities like painting a house or planting a tree do not have the same level of environmental significance and do not require formal environmental assessments.

144. (B) Providing protection to specified plant species and regulating the trade of vulnerable and endangered species.
The 1991 amendment to the Wildlife Protection Act was a significant expansion of the national conservation framework. For the first time, it included provisions specifically for the protection of rare and endangered plant species. The amendment allowed the government to regulate the trade and exploitation of these plants, recognizing their importance to biodiversity and ecosystem health. This change strengthened the state's ability to protect the entire natural heritage of the country, ensuring that both fauna and flora receive the legal protection needed for their long-term survival.

NODIA

145. (B) Lack of scientific certainty shall not be used to postpone measures to prevent degradation when serious threats exist.
The precautionary principle is a fundamental concept in environmental law suggesting that when there are threats of serious or irreversible damage, a lack of full scientific certainty should not be used as a reason to delay action. This principle prioritizes the prevention of environmental degradation and the protection of public health. It places the burden of proof on the proponents of an activity to show that it is safe, rather than requiring the public to prove it is harmful. This proactive approach ensures that potential risks are addressed early.

146. (A) Both Statement I and Statement II are true.
The National Water Policy of 2002 established clear priorities and principles for water management in India. It gives the highest priority to drinking water in the allocation of water resources, recognizing it as a fundamental need. The policy also advocates for a decentralized and participatory approach, emphasizing the importance of community involvement in the planning and management of water resources.

the environment, including the management of hazardous substances and waste. Often called an umbrella legislation, it empowers the government to take all necessary measures to protect the environment and coordinate the activities of various authorities, ensuring a unified approach to ecological management.

108. (B) Provide detailed procedures and standards for implementing the Act's provisions.
The Environmental Protection Rules of 1986 were notified to provide the necessary detail for implementing the broad provisions of the parent Act. These rules establish specific procedures for setting environmental standards, handling hazardous substances, and conducting environmental assessments. They also define the powers and duties of various authorities and outline the processes for making complaints and taking legal action. By providing these detailed operational guidelines, the rules ensure that the Environment Protection Act is effectively and consistently applied across the country.

109. (A) 1, 2 and 3 only
An environmental management system is a voluntary framework used by organizations to manage and improve their environmental performance. ISO 14001 is the leading international standard for such systems, providing a structured approach for achieving sustainability goals. Adopting these systems can lead to improved compliance and better environmental outcomes. While often used by large corporations, an EMS is applicable to organizations of all sizes and sectors. It helps them systematically identify and control their environmental impacts, promoting continuous improvement in resource use and pollution prevention.

110. (D) The Batteries (Management and Handling) Rules, 2010
In India, the management and recycling of lead-acid batteries are specifically governed by the Batteries Management and Handling Rules. These rules place the primary responsibility on manufacturers, importers, and assemblers to collect used batteries from consumers and ensure they are sent to authorized recyclers. By establishing this extended producer responsibility, the rules aim to prevent hazardous lead from entering the waste stream and contaminating the soil and water. The rules promote the safe and sustainable recovery of lead, a valuable but toxic material.

111. (A) A critical examination of the EIA report by an expert committee and regulatory authority before a decision is made.
The review of an environmental impact assessment report is a formal process where an expert committee and the regulatory authority examine the findings and conclusions of the study. This review ensures that the assessment is thorough, accurate, and complies with all legal requirements. It also considers the results of public consultations and other stakeholder feedback. The critical examination of the report is essential for providing decision-makers with a reliable and scientifically sound basis for deciding whether to approve a developmental project.

NODIA

112. (D) P-3, Q-4, R-2, S-1
Indian environmental legislation addresses various ecological and social challenges through specialized laws. The Biological Diversity Act focuses on benefit sharing from genetic resources, while the Public Liability Insurance Act provides relief for victims of industrial accidents. Noise pollution standards are established through specific regulatory rules, and the diversion of forest land for non-forest uses is controlled by the Forest Conservation Act. Together, these laws form a multi-faceted regulatory framework that protects the country's diverse natural heritage and promotes public safety and well-being.

113. (B) The Brundtland Commission Report, 1987
The widely accepted definition of sustainable development as development that meets present needs without compromising future generations was popularized by the 1987 Brundtland Commission Report. Also known as Our Common Future, the report highlighted the urgent need to balance economic growth with environmental protection and social equity. This foundational document brought the concept of sustainability to the forefront of international policy, leading to the 1992 Earth Summit and shaping subsequent global agreements and efforts to achieve a more sustainable and just future for the entire planet.

114. (A) Waste oil and contaminated sludge from an industrial process.
The Hazardous and Other Waste Rules of 2016 specifically target waste that poses a significant threat to human health or the environment. This includes waste oil, contaminated sludge, and other toxic residues from industrial processes. Unlike municipal or household waste, these materials require specialized handling, storage, and disposal methods to prevent serious contamination. The rules establish a comprehensive framework for managing these hazardous materials throughout their lifecycle, including their transboundary movement, ensuring that they are managed in an environmentally sound manner.

115. (C) Cost-Benefit Analysis
A study that weighs the financial costs of a project against its anticipated benefits, including environmental and social factors, is called a cost-benefit analysis. This analytical tool helps decision-makers determine whether a project is economically viable and socially desirable. By assigning monetary values to various impacts, such as reduced pollution or improved travel time, the analysis provides a common basis for comparison. While challenging for intangible environmental goods, this method is a standard part of evaluating large-scale infrastructure projects like metro lines.

116. (D) Statement I is false, but Statement II is true.
The National Environmental Policy of 2006 is a policy document rather than a legally binding statute. While it is not directly enforceable in a court of law like an Act of Parliament, it serves as a critical guideline for the government. It informs decision-making and the formulation of new laws and regulations related to the environment. The policy provides a strategic framework for achieving sustainable development, ensuring that environmental concerns are consistently considered across various sectors and levels of government activity in the country.

117. (C) Secure renewed political commitment for sustainable development.
A main goal of the Rio+20 United Nations Conference on Sustainable Development was to secure renewed political commitment for global sustainability. Held twenty years after the first Earth Summit, the conference aimed to assess progress, address new and emerging challenges, and revitalize international efforts. The summit resulted in the document The Future We Want, which reaffirmed the principles of the original Rio Declaration and set the stage for the development of the Sustainable Development Goals, highlighting the ongoing need for global cooperation and action.

118. (B) Stockholm Conference, 1972
The 1972 Stockholm Conference on the Human Environment was the first international gathering to recognize the need for a coordinated global approach to environmental problems. It brought together nations from around the world to discuss the impact of human activities on the planet and to establish principles for environmental management. The conference led to the creation of the United Nations Environment Programme and paved the way for many subsequent international treaties and summits, marking the beginning of modern international environmental governance and cooperation.

119. (A) 1, 2, and 3 only
The primary objectives of an environmental impact assessment are to identify potential environmental impacts, propose mitigation measures, and inform both decision-makers and the public. By evaluating projects before they are implemented, the process ensures that environmental concerns are considered and that negative consequences are minimized. It does not guarantee project approval or focus solely on economic profit; instead, it provides a balanced and scientific assessment of a project's overall sustainability, helping to ensure that development does not come at an unacceptable environmental cost.

120. (A) Both A and R are true and R is the correct explanation of A.
The Biological Diversity Act of 2002 establishes a unique three-tier institutional structure to manage and conserve the country's biodiversity. This includes the National Biodiversity Authority at the central level, State Biodiversity Boards at the state level, and Biodiversity Management Committees at the local level. This structure is specifically designed to facilitate decentralized management and ensure that local communities are involved in the conservation and sustainable

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use of biological resources, promoting a more participatory and equitable approach to biodiversity governance.

121. (C) National Environmental Policy, 2006
The National Environmental Policy of 2006 explicitly incorporates key environmental principles, such as the precautionary principle and the polluter pays principle, into its framework. These principles guide the government's approach to environmental management, emphasizing the need for caution in the face of scientific uncertainty and the responsibility of polluters to bear the costs of environmental damage. By formalizing these principles in a national policy document, the government reaffirms its commitment to sustainable development and the integration of environmental concerns into all aspects of policymaking.

122. (A) The Project Proponent/Developer
Under the environmental impact assessment notification, the primary responsibility for conducting the assessment and preparing the report lies with the project proponent or developer. While the study is often carried out by specialized consultants, the proponent is responsible for the accuracy and completeness of the information provided. This ensuring that the entity proposing the development is also the one that evaluates its potential environmental impacts. The government's role is to review the assessment and decide whether to grant environmental clearance based on the findings.

123. (D) Regulating developmental activities to protect fragile coastal ecosystems.
Coastal Regulation Zone rules are designed to protect and conserve the delicate ecosystems found along the country's coastlines. They regulate developmental activities, such as construction and industrial projects, within a specific distance from the high tide line. By classifying the coast into different zones based on their ecological sensitivity, the rules ensure that development is balanced with the need to protect mangroves, coral reefs, and other vital coastal habitats. This regulatory framework is essential for maintaining coastal resilience and protecting the livelihoods of coastal communities.

124. (B) The EMP is a section within the EIS that outlines mitigation and management actions.
In an environmental impact assessment report, the Environmental Management Plan is a critical component that details the practical actions needed to manage environmental impacts. It is typically a section within the overall Environmental Impact Statement. The plan outlines the specific mitigation measures, monitoring protocols, and institutional arrangements that will be implemented during the project's construction and operation. By providing a clear roadmap for environmental management, the EMP ensures that the findings and commitments made in the impact statement are effectively carried out on the ground.

125. (C) Wetlands
The Ramsar Convention is an international treaty dedicated to the conservation and sustainable use of wetlands. It recognizes the vital ecological functions of wetlands, such as water purification, flood control, and providing habitats for a wide range of species. The convention encourages parties to designate significant wetlands as Wetlands of International Importance and to promote their wise use. By protecting these productive ecosystems, the Ramsar Convention contributes to global biodiversity conservation and the long-term well-being of communities that depend on wetland resources.

NODIA

126. (C) P-2, Q-4, R-1, S-3
Environmental management involves several distinct tools with different purposes and timelines. Impact assessments are predictive tools used for proposed projects, while life-cycle analysis provides a cradle to grave assessment of products. Environmental audits are used to review the performance of existing operations against established criteria. Finally, cost-benefit analysis evaluates projects in monetary terms, helping to weigh economic advantages against environmental and social costs. Together, these tools provide a comprehensive framework for assessing and managing the environmental impacts of human activities and promoting sustainable development.

127. (A) The power of the central government to take all necessary measures for environmental protection.

The amendment of the Air Act to include noise as a pollutant was made possible by the broad powers granted to the central government under the Environment Protection Act of 1986. This umbrella legislation empowers the government to take all measures deemed necessary for environmental protection, including the coordination of various specialized laws. By using these powers, the government could expand the definition of air pollution to include noise, recognizing its harmful effects and ensuring it could be regulated under the existing framework of the Air Act.

128. (A) 4, 3, 1, 2`
India's key environmental laws were enacted progressively to address diverse ecological challenges. The Wildlife Protection Act was passed in 1972, followed by the Water Act in 1974. The Air Act was introduced in 1981 to control atmospheric pollution. Finally, the comprehensive Environment Protection Act was enacted in 1986 as an umbrella legislation. This chronological development shows the evolving national commitment to environmental protection, with each law expanding the regulatory framework and strengthening the state's ability to conserve resources and manage pollution effectively.

129. (D) Statement I is false, but Statement II is true.
The principal legislation for the protection of biodiversity in India is the Biological Diversity Act of 2002 This Act was specifically enacted to fulfill the country's obligations under the international Convention on Biological Diversity. While the Indian Forest Act deals with forest administration and timber transit, it is not the primary law for biodiversity conservation. The Biological Diversity Act provides a comprehensive framework for conserving biological resources and ensuring the fair and equitable sharing of benefits, marking a significant step in the national effort to protect natural heritage.

130. (A) Kyoto Protocol
The Clean Development Mechanism is a flexible mechanism established under the Kyoto Protocol to help developed countries meet their greenhouse gas emission reduction targets. It allows these countries to invest in emission-reduction projects in developing nations, for which they receive certified emission reduction credits. This mechanism promotes technology transfer and sustainable development in developing countries while providing a cost-effective way for developed nations to achieve climate goals. It represents a key international effort to address global warming through cooperation between developed and developing nations.

131. (B) 3, 1, 4, 2`
The risk assessment process follows a systematic scientific sequence to evaluate potential hazards. It typically begins with hazard accounting to create an inventory of materials, followed by hazard identification to determine their potential for harm. Next, exposure scenarios are developed to analyze how people or the environment might come into contact with the hazard. Finally, risk characterization integrates all the information to estimate the probability and severity of adverse effects. This structured approach ensures that all relevant data is considered before making decisions about risk management.

132. (D) Provide funds for the CPCB and SPCBs.
The Water Cess Act of 1977 was introduced to generate financial resources for the Central and State Pollution Control Boards. It mandates the collection of a cess or fee from certain industries and local authorities based on their water consumption. The funds collected are used to support the operations of the pollution control boards, including monitoring, enforcement, and research activities. By providing a dedicated source of funding, the Act ensures that the boards have the necessary resources to effectively implement water pollution control laws.

133. (C) All developmental activities
The National Environmental Policy of 2006 aims to mainstream environmental concerns into all stages of developmental activities. It advocates for the integration of environmental considerations into policies, plans, and programs across all sectors of the economy, including industry, agriculture, and urban development. By ensuring that environmental consequences are considered early in the planning process, the policy promotes sustainable development and minimizes negative impacts on natural resources and public health. This holistic approach reflects a commitment to

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balancing economic growth with the long-term preservation of the environment.

134. (B) ISO 14000 series
For a manufacturing company seeking to implement a formal system to manage its environmental responsibilities, the ISO 14000 series is the most appropriate choice. This international standard provides a voluntary framework for establishing an effective environmental management system. It guides organizations on how to identify their environmental impacts, set performance goals, and continuously improve their environmental performance. By adopting this series, a company can demonstrate its commitment to environmental protection and enhance its credibility with customers, regulators, and other stakeholders concerned about sustainability.

135. (A) Both A and R are true and R is the correct explanation of A.
The Montreal Protocol is widely regarded as one of the most successful international environmental agreements ever signed. Its success is primarily due to its effectiveness in reducing the global production and consumption of ozone-depleting substances. Through a clear and legally binding schedule for phasing out these chemicals, the protocol has led to significant recovery of the stratospheric ozone layer. This achievement demonstrates the power of international cooperation and science-based policy in addressing critical global environmental challenges and protecting the planet's essential life-support systems.

136. (A) The Environmental (Protection) Act, 1986
The comprehensive suite of waste management rules notified by the Indian government in 2016 was promulgated under the authority of the Environment Protection Act of 1986. This parent Act serves as an umbrella legislation, providing the central government with broad powers to make rules for protecting and improving the environment. By using these powers, the government could establish updated and specialized regulations for different types of waste, ensuring a more unified and effective approach to environmental management and resource recovery across various industrial and domestic sectors.

NODIA

137. (C) To provide a justification for approving a project irrespective of its environmental impacts.
The primary aims of an environmental impact assessment are to identify, predict, and evaluate the potential consequences of a project and to propose mitigation measures. It is intended to ensure that environmental considerations are integrated into planning and decision-making. Crucially, the process is not meant to provide a justification for approving projects regardless of their impacts. Instead, it provides a scientific and objective assessment that allows decision-makers to weigh the environmental costs against the benefits and determine whether a project should proceed or be modified.

138. (A) The 1980 Act regulates diversion of forest land, while the 1982 Act deals with forest administration and transit of forest produce.
The Forest Conservation Act of 1980 and the Indian Forest Act serve distinct purposes in forest management. The 1980 Act is specifically focused on conservation, regulating the diversion of forest land for non-forest uses and requiring central government approval. In contrast, the Indian Forest Act deals primarily with the administration of forests, the regulation of the transit of forest produce, and the levying of duties on timber. While both are essential for forest governance, their legal focus and objectives are fundamentally different, reflecting different aspects of forest policy.

139. (D) 1, 2, 3, and 4`
Major international environmental agreements are each designed to address a specific global challenge. The Montreal Protocol successfully targets ozone-depleting substances, while the Kyoto Protocol commits parties to reducing greenhouse gas emissions. The Basel Convention provides a framework for controlling the transboundary movement and disposal of hazardous wastes. Finally, the Ramsar Convention focuses on the conservation and wise use of wetlands. Together, these agreements represent a coordinated global effort to protect the environment and promote sustainable management of the planet's diverse and vital natural resources.

140. (B) Extended Producer Responsibility

approach allows for a more efficient and localized assessment of projects, while still ensuring that significant environmental concerns are addressed before developmental activities are permitted to proceed in different regions.

101. (A) 1, 2, 3 and 4 only
Indian environmental law is built on a strong constitutional and legal foundation. Article 48A and Article 51A establish duties for both the state and citizens to protect the environment. Major laws like the Water Act and the Air Act were enacted before the comprehensive Environment Protection Act of 1986. While the Wildlife Protection Act is for conserving diverse fauna and flora, it is not primarily for agricultural crops. This multi-layered framework provides the legal tools needed for environmental management and conservation across the country.

102. (B) The product meets certain environmental standards compared to other products in the same category.
An eco-label is a voluntary certification that informs consumers that a product has met specific environmental performance criteria throughout its life cycle. It indicates that the product is less harmful to the environment than other similar products in its category. By providing clear and reliable information, eco-labels help consumers make environmentally conscious choices and encourage manufacturers to adopt more sustainable practices. This market-based tool promotes the development and consumption of environmentally friendly products, contributing to overall ecological sustainability.

103. (D) Introduce stricter penalties and strengthen the powers of the pollution control boards.
The 1988 amendment to the Water Act was designed to improve the enforcement of water pollution control laws. It introduced stricter penalties for non-compliance and strengthened the powers of the central and state pollution control boards. The amendment allowed boards to close down polluting industries and cut off their water and electricity supplies, providing more effective tools for ensuring industrial compliance with environmental standards. These changes reflected a growing recognition of the need for stronger regulatory enforcement to protect the country's water resources.

104. (A) Maximizing revenue from forests to fund other government projects.
The National Forest Policy of 1988 moved away from the commercial exploitation of forests toward ecological preservation. Its objectives include maintaining environmental stability, conserving natural heritage, and checking soil erosion. It explicitly does not aim to maximize revenue from forest resources for other government projects. Instead, the policy prioritizes the essential ecological services provided by forests and the needs of local communities for fuel and fodder, ensuring that forest management is sustainable and supports the long-term well-being of people and the environment.

105. (A) Both A and R are true and R is the correct explanation of A.
Scoping is a critical and mandatory phase in the environmental impact assessment process. Its primary purpose is to identify the most significant environmental issues and impacts that need detailed investigation, out of a wide range of potential concerns. By focusing on the key issues, scoping ensures that the assessment is efficient and that resources are directed toward the most important impacts. This process also involves consulting with stakeholders to ensure that their concerns are included in the study's scope.

106. (A) Goal 7: Ensure environmental sustainability
Among the eight Millennium Development Goals adopted by the United Nations in 2000, Goal Seven is the one most directly related to the environment. It aims to ensure environmental sustainability by integrating sustainable development principles into national policies and reversing the loss of environmental resources. The goal includes specific targets for increasing access to clean water and sanitation and improving the lives of slum dwellers. It highlights the fundamental importance of a healthy environment for achieving overall global development and poverty reduction goals.

107. (D) The Environmental (Protection) Act, 1986
The Environmental Protection Act of 1986 provides the most comprehensive and holistic legal framework for environmental protection in India. Unlike earlier laws that focused on specific media like air or water, the EP Act allows the central government to address all aspects of

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These principles aim to ensure that water is used efficiently and sustainably, balancing the needs of different sectors while protecting the environment and public health.

147. (C) Documenting the location, quantity, and properties of hazardous substances.
Hazard accounting is a technical process within risk assessment that involves creating a detailed record of the hazardous materials present at a facility. This includes documenting their specific locations, the quantities stored or used, and their chemical and physical properties. By providing a clear inventory of potential hazards, this process helps in identifying and characterizing risks, planning for emergencies, and ensuring that appropriate safety and management measures are in place. It is a foundational step for effective risk assessment and the safe handling of hazardous substances.

148. (D) The Rio de Janeiro Earth Summit, 1992
The 2002 World Summit on Sustainable Development in Johannesburg was a major follow-up to the 1992 Rio Earth Summit. Held ten years after the first Earth Summit, the Johannesburg conference aimed to review the progress made in implementing Agenda 21 and to re-energize the global commitment to sustainable development. It focused on practical implementation strategies and partnerships to address poverty and environmental degradation. The summit highlighted the continuing challenges of achieving sustainable development and the need for more effective international cooperation and action across all sectors.

149. (B) 1, 2, and 4 only
Several environmental management tools are used to predict the potential consequences of proposed projects. Impact assessments, life-cycle analysis, and cost-benefit analysis are all predictive in nature, helping decision-makers evaluate future impacts before they occur. These tools identify potential risks, estimate the magnitude of effects, and compare different project alternatives. In contrast, environmental audits are retrospective tools used to evaluate the performance and compliance of existing operations. Together, these predictive and evaluative tools provide a comprehensive framework for managing environmental impacts and promoting sustainable development across different industries.

150. (B) 10:00 PM and 6:00 AM
To protect public health and ensure quiet during nighttime, the Noise Pollution Rules of 2000 generally restrict the use of loudspeakers between 10:00 PM and 6:00 AM. This restriction applies across different area classifications and is intended to prevent excessive noise from disrupting sleep and causing other negative health effects. While temporary exemptions may be granted for festivals and special occasions, these rules provide a standard legal framework for regulating noise levels and protecting the well-being of the population during the sensitive nighttime hours.

151. (D) It mandates a minimum thickness for plastic carry bags.
A key provision of the Plastic Waste Management Rules of 2016 is the mandate for a minimum thickness for plastic carry bags. By requiring bags to be thicker, the rules aim to make them more reusable and easier for waste pickers to collect and for recyclers to process. This measure is intended to discourage the use of thin, single-use plastics that are difficult to manage and often end up as litter in the environment. The rules also place responsibility on producers to manage the waste generated by their products.

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152. (A) Both A and R are true and R is the correct explanation of A.
The Environment Protection Act of 1986 grants significant powers to the central government, allowing it to take all measures deemed necessary for environmental protection. This broad authority was considered essential to create a comprehensive legal framework and fill the gaps left by earlier, more specialized legislation like the Water and Air Acts. By acting as an umbrella legislation, the EP Act enables the government to coordinate activities across different sectors and authorities, ensuring a more unified and holistic approach to managing the country's diverse and complex environmental challenges.

153. (C) An Environmental Management Plan (EMP)
A plan that details specific actions, timelines, and responsibilities for preventing pollution and ensuring regulatory compliance for an existing

Risk assessment involves the systematic identification and evaluation of potential hazards and their consequences. In a chemical factory, this includes analyzing various accident scenarios, such as chemical leaks, fires, and explosions, and determining their potential impact on human health and the environment. By characterizing these risks, the factory can identify the most significant threats and develop appropriate management and mitigation strategies. This scientific process is essential for ensuring industrial safety, protecting workers and surrounding communities, and minimizing the potential for environmental damage from hazardous industrial operations.

167. (D) Provide policymakers with regular scientific assessments on climate change.
The primary role of the IPCC is to provide policymakers with objective and scientifically sound assessments of climate change. It does not conduct its own research; instead, it synthesizes the latest peer-reviewed scientific data from around the world. These regular reports cover the physical science of climate change, its potential impacts, and strategies for adaptation and mitigation. By providing a clear and comprehensive summary of the current scientific consensus, the IPCC assessments serve as a critical foundation for international climate negotiations and the development of national and global climate policies.

168. (A) 3 only
The Environment Protection Act of 1986 is unique among Indian environmental laws because it provides the central government with overriding powers to make rules for environmental protection. Often called an umbrella legislation, it empowers the government to take any measures it deems necessary to protect the environment and to coordinate the activities of various state and central authorities. This broad authority allows the government to set national standards and procedures for a wide range of issues, ensuring a unified and comprehensive approach to environmental management across the entire country.

169. (A) Both A and R are true and R is the correct explanation of A.
The 2006 impact assessment notification makes public consultation a mandatory and critical step for many developmental projects. This ensures that the concerns of local residents and other stakeholders who might be affected by a project are officially heard and considered. By providing a platform for public participation, the process promotes transparency and ensures that local knowledge and feedback are incorporated into the decision-making process. This inclusive approach helps to improve the quality of environmental assessments and ensures that projects are socially acceptable and more sustainable.

170. (A) Encouraging the mixing of bio-medical waste with municipal solid waste.
The Bio-Medical Waste Management Rules of 2016 strictly prohibit the mixing of infectious hospital waste with municipal solid waste. Instead, they mandate the segregation of waste at the source into specialized color-coded bags and containers. The rules prescribe specific treatment and disposal methods, such as incineration or autoclaving, to ensure that hazardous biological materials are rendered safe before final disposal. Proper authorization and record-keeping are required for all healthcare facilities to ensure compliance and protect public health from the risks of infectious and hazardous medical waste.

171. (D) Ramsar Convention
The wise use principle is a fundamental component of the Ramsar Convention on Wetlands. It emphasizes the conservation and sustainable use of wetlands and their resources, balancing ecological protection with the economic and social needs of human communities. The convention encourages parties to manage wetlands in a way that maintains their ecological character while allowing for activities that benefit people without compromising the resource for the future. This holistic approach recognizes the vital role of wetlands in providing essential ecosystem services and supporting global biodiversity and livelihoods.

172. (B) The governance of water resources, including planning, development, and management.
The National Water Policy of 2002 was formulated to provide a comprehensive framework for the governance of water resources in India. It addresses all aspects of water management,

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instead addressed by other major international agreements like the climate change convention.

160. (B) Montreal deals with ozone depletion, while Kyoto deals with climate change.
A key difference between the Montreal Protocol and the Kyoto Protocol lies in the specific environmental issues they address. The Montreal Protocol is an international agreement dedicated to protecting the stratospheric ozone layer by phasing out ozone-depleting substances. In contrast, the Kyoto Protocol is an extension of the climate change convention, focusing on the reduction of greenhouse gas emissions to mitigate global warming. While both protocols involve international cooperation to address atmospheric challenges, their goals and the specific substances they regulate are fundamentally different, reflecting different global priorities.

161. (A) Environmental Impact Statement (EIS)
The technical document that presents the findings of an environmental impact assessment is known as the Environmental Impact Statement. It provides a detailed account of the baseline environmental data, predicts potential impacts, and outlines the management and mitigation measures included in the Environmental Management Plan. The statement serves as the primary report used by regulatory authorities and stakeholders to evaluate the environmental implications of a proposed project. By providing a clear and comprehensive assessment, it ensures that developmental decisions are made with a thorough understanding of their potential consequences.

162. (A) Both Statement I and Statement II are true.
The Wildlife Protection Act of 1972 is a comprehensive law that prohibits the hunting of animals listed in its various schedules. It also provides a legal framework for the regulation of trade in wildlife products and the establishment and management of zoos. By addressing both the direct exploitation of animals and the commercial aspects of wildlife, the Act provides a robust system for protecting the country's diverse fauna. Its provisions ensure that wildlife is conserved and that any activities involving wild animals are conducted in a regulated and sustainable manner.

163. (C) 33 percent
The National Forest Policy of 1988 established a target of having a minimum of 33 percent of the country's total land area under forest or tree cover. This goal is intended to ensure environmental stability and maintain ecological balance, recognizing the vital role of forests in soil conservation, water management, and biodiversity protection. In hilly and mountainous regions, the policy recommends a higher target of 66 percent to prevent erosion and landslides. This ambitious target reflects a fundamental commitment to restoring and preserving the country's essential forest ecosystems for future generations.

164. (D) The Copenhagen Accord, a non-binding political agreement.
The 2009 Copenhagen Climate Summit was a significant moment in international climate negotiations, but it did not result in a new legally binding treaty. Instead, it produced the Copenhagen Accord, which was a non-binding political agreement among major nations. The accord recognized the scientific need to limit global temperature rise to below two degrees Celsius and included voluntary commitments for emission reductions. While criticized for its lack of legal force, the accord represented a key step in building international consensus on the urgency of climate change and the need for coordinated global action.

165. (C) The compliance and environmental performance of an existing operation or facility.
An environmental audit is a systematic evaluation of an existing facility's performance against established environmental criteria and regulatory requirements. Unlike impact assessments, which are predictive tools for new projects, audits provide a retrospective view of current operations. They identify areas of non-compliance, evaluate the effectiveness of management systems, and help companies improve their environmental performance and reduce ecological liabilities. By providing a clear and objective assessment of current practices, an audit ensures that organizations are meeting their environmental responsibilities and operating in a sustainable and compliant manner.

166. (B) Risk Assessment

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By covering all urban and semi-urban areas, the rules ensure a more consistent and effective approach to managing municipal waste across diverse settlements. The rules mandate waste segregation at the source and promote recycling and composting, aiming to reduce the volume of waste sent to landfills and improve overall urban environmental quality.

179. (D) Statement I is false, but Statement II is true.
The primary objective of the Forest Conservation Act of 1980 is to check the indiscriminate diversion of forest land for non-forest purposes, such as industrial or infrastructure projects. It is not primarily focused on regulating the cutting of trees on private properties. The Act mandates that any proposal to use forest land for other uses must obtain prior approval from the central government, ensuring that the impact on forest cover is carefully evaluated. This centralized oversight is essential for maintaining the country's forests and protecting the ecological services they provide.

180. (D) Cost-Benefit Analysis
A cost-benefit analysis is an analytical tool used to evaluate the economic feasibility and social desirability of a project by comparing its total costs with its total benefits. In the context of developmental activities, this involves weighing the financial costs of construction and operation against benefits like improved infrastructure or reduced pollution. By assigning monetary values to various impacts, the analysis helps decision-makers determine whether a project provides a net benefit to society. While complex for environmental factors, this method is a standard part of evaluating the overall sustainability of projects.

181. (D) 1, 2, 3 and 4`
India's environmental laws provide a robust framework for managing pollution and conserving resources. The Environment Protection Act empowers the central government to set national standards, while the Water Act led to the creation of pollution control boards. The Air Act was originally focused on atmospheric pollutants before being amended to include noise. The Wildlife Protection Act establishes a legal system for the creation and management of protected areas like National Parks. Together, these laws form a multi-faceted regulatory system that addresses diverse ecological concerns and promotes sustainable development across the country.

182. (B) Environmentally friendly consumer products
The Ecomark scheme in India is a voluntary labeling system for consumer products that meet specific environmental criteria. It informs consumers that a product has a lower environmental impact throughout its lifecycle compared to other similar products. By providing clear and reliable information, the Ecomark helps consumers make environmentally conscious choices and encourages manufacturers to adopt more sustainable practices. This market-based tool promotes the production and consumption of environmentally friendly goods, contributing to overall ecological sustainability and promoting a culture of environmental responsibility among both producers and consumers.

183. (D) Earth Summit at Rio de Janeiro, 1992
The landmark Earth Summit held in Rio de Janeiro in 1992 is officially known as the United Nations Conference on Environment and Development. It was a historic gathering that brought together nations from around the world to discuss the relationship between economic growth and environmental protection. The conference produced several key outcomes, including Agenda 21, the Rio Declaration on Environment and Development, and the United Nations Framework Convention on Climate Change. It marked a major turning point in global environmental policy, firmly establishing the concept of sustainable development as a primary goal.

184. (A) Strengthen the rules and bring them in line with international standards.
The amendment to the Hazardous Chemical Rules in 2000 was intended to strengthen the national regulatory framework for industrial safety and align it with international standards. These rules mandate that facilities handling hazardous chemicals must implement rigorous safety measures, prepare emergency response plans, and provide information to authorities and the public. By improving the management of hazardous substances throughout their lifecycle, the rules aim to minimize the risk of industrial

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including planning, development, and allocation among different sectors. The policy emphasizes the need for a holistic and river-basin oriented approach, prioritizing drinking water and advocating for community participation and the integration of environmental concerns. By establishing these guiding principles, the policy aims to ensure that the country's scarce water resources are managed sustainably and efficiently for the benefit of all.

173. (B) Convention on Biological Diversity and UNFCCC
The Global Environmental Facility serves as the primary financial mechanism for several major international environmental conventions, including the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change. It provides grants and concessional funding to developing countries to help them implement projects that address global environmental issues. By assisting nations in meeting their treaty obligations, the facility plays a critical role in supporting international efforts to conserve biodiversity, mitigate climate change, and promote sustainable development, ensuring that financial resources are directed toward the most pressing global environmental challenges.

174. (D) The personal income of the consumer who buys the bottle.
A life-cycle analysis evaluates the environmental impact of a product throughout its entire life, from raw material extraction to final disposal. For a plastic bottle, this includes analyzing petroleum extraction, manufacturing processes, and the environmental consequences of transportation and usage. While these factors relate to the physical lifecycle of the product, the personal income of the consumer is a socio-economic factor that does not directly influence the bottle's environmental footprint. Consequently, economic indicators like personal income are excluded from the scope of an environmental life-cycle assessment.

175. (A) To set specific targets for poverty reduction, health, education, and environmental sustainability.
The primary agenda of the 2000 United Nations Millennium Summit was to establish the Millennium Development Goals. These eight time-bound and measurable goals were designed to address the most pressing global challenges, including extreme poverty, hunger, disease, and environmental degradation. Goal Seven specifically focused on ensuring environmental sustainability. The summit represented a historic global consensus and commitment to improve the lives of millions of people and protect the planet's essential life-support systems, setting a clear framework for international development and cooperation in the twenty-first century.

176. (B) Environment (Protection) Act, 1986
The Environment Protection Act of 1986 is widely known as an umbrella legislation because it provides a comprehensive legal framework for environmental management in India. It grants the central government broad powers to take all necessary measures for environmental protection and to coordinate the activities of various specialized authorities. Unlike laws that focus on specific media like air or water, the EP Act allows the government to set national standards, manage hazardous substances, and address diverse environmental issues in a holistic and integrated manner, filling gaps in earlier legislation.

177. (A) P-4, Q-1, R-3, S-2`
International environmental agreements were adopted progressively to address emerging global issues. The Stockholm Conference took place in 1972, marking the beginning of modern global environmental governance. The Montreal Protocol on ozone protection was signed in 1987, followed by the landmark Rio Earth Summit in 1992 Finally, the Kyoto Protocol was adopted in 1997, setting binding targets for greenhouse gas reductions. This timeline shows the evolution of international efforts from foundational meetings to specific treaties addressing chemical pollution, sustainable development, and global climate change challenges over several decades.

178. (A) Every urban local body, outgrowths in urban agglomerations, census towns, notified industrial townships, and other areas.
The Solid Waste Management Rules of 2016 have a wide and comprehensive scope, applying beyond major municipalities to every urban local body in the country. This includes urban outgrowths, census towns, and notified industrial townships.

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facility is called an Environmental Management Plan. It outlines how an organization will manage its environmental impacts on a day-to-day basis, including mitigation measures, waste handling protocols, and monitoring schedules. By providing a clear roadmap for environmental management, the plan ensures that environmental goals are consistently pursued and that the organization's activities are balanced with the need to protect the environment and maintain sustainable operations.

154. (A) COP 3 (Kyoto)
The Kyoto Protocol, a landmark international treaty for reducing greenhouse gas emissions, was adopted at the third Conference of the Parties to the United Nations Framework Convention on Climate Change. Held in Kyoto, Japan, in 1997, COP 3 was a significant moment in global climate policy, as it established legally binding emission reduction targets for developed countries. This COP represented a major step forward in international climate negotiations, demonstrating a collective commitment to address global warming through coordinated and measurable actions by the world's most industrialised nations.

155. (D) Article 48A
Article 48A was added to the Directive Principles of State Policy by the 42nd Constitutional Amendment Act in 1976. This provision imposes a clear duty on the state to protect and improve the environment and to safeguard the country's forests and wildlife. It provides the constitutional foundation for national environmental laws and policies, ensuring that environmental protection is recognized as a primary responsibility of the government. This article reflects a fundamental commitment to maintaining ecological balance and protecting natural resources for the well-being of both present and future generations.

156. (D) Exposure Assessment
Exposure assessment is the process of identifying how a receptor, such as a human population or an ecosystem, might come into contact with a hazardous substance. It involves analyzing the pathways through which the substance travels, identifying the routes of exposure, and estimating the frequency and duration of contact. By understanding these exposure pathways, researchers can determine the magnitude of potential risks and identify the most vulnerable groups. This information is critical for characterizing the overall risk posed by a hazard and developing effective strategies for risk management and control.

157. (A) P-3, Q-4, R-1, S-2
India's waste management rules of 2016 address different types of waste through specialized regulations. Municipal garbage is governed by the Solid Waste Rules, while industrial sludge and chemical residues fall under the Hazardous Waste Rules. Waste from hospitals and clinics requires strict handling according to the Bio-Medical Waste Rules, and discarded electronics like refrigerators and computers are managed under the e-waste Rules. This categorical approach ensures that each waste stream is managed appropriately, minimizing environmental risks and promoting the recovery of valuable resources through specialized treatment and recycling.

158. (D) Consolidate the law relating to forests, the transit of forest-produce, and the duty leviable on timber.
The Indian Forest Act is a key piece of legislation that consolidates the laws regarding forest management and the commercial aspects of timber. It provides the legal framework for the transit of forest produce, the levying of duties on timber, and the regulation of various forest-related activities. While later laws focus more on conservation and biodiversity, this Act remains foundational for the state's administration and control of forest resources. It ensures that forest products are managed and traded in a regulated manner, supporting both the state's revenue and the administration of forest lands.

159. (A) 1, 2, and 3 only
The Basel Convention is an international treaty adopted in 1989 to control the transboundary movement of hazardous wastes and ensure their sound management. It aims to protect human health and the environment by minimizing the generation of hazardous waste and preventing its transfer to developing countries for disposal. The convention establishes strict notification and movement procedures, but it does not encourage waste dumping. Furthermore, it is not primarily focused on greenhouse gas emissions, which are

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accidents and protect human health and the environment from the harmful consequences of chemical spills or releases.

185. (D) A is false but R is true.
An Environmental Management Plan must be a dynamic and evolving document rather than a static one. To be effective, the plan should be adaptable to changing project conditions and the results of ongoing environmental monitoring. As new information becomes available or as operational challenges arise, the plan must be updated to ensure that mitigation measures remain effective and that environmental performance is continuously improved. This flexible approach allows organizations to respond proactively to environmental risks and maintain their commitment to sustainability throughout the entire lifecycle of a project.

186. (A) Combining information from exposure and toxicity assessments to estimate the probability and severity of an adverse effect.
Risk characterization is the final and critical phase of the risk assessment process. it involves integrating all the gathered information from hazard identification, toxicity assessments, and exposure analysis to estimate the overall magnitude of the risk. By combining these different data sets, researchers can provide a scientific estimate of the probability and severity of adverse effects in a target population or ecosystem. This comprehensive summary provides the necessary evidence for decision-makers to develop and implement effective risk management and mitigation strategies.

187. (D) To integrate environmental concerns into all stages of policy making.
A key objective of the National Environmental Policy of 2006 is to integrate environmental concerns into all stages of policy making and development planning. This holistic approach ensures that environmental consequences are considered alongside economic and social factors from the very beginning. By mainstreaming environmental considerations across all sectors, the policy promotes sustainable development and minimizes negative impacts on natural resources and public health. This commitment reflects a recognition that a healthy environment is essential for long-term economic prosperity and the well-being of all citizens in the country.

188. (C) Wildlife Protection Act, 1972 - Regulation of industrial emissions.
The Wildlife Protection Act of 1972 is primarily focused on the conservation of wild animals, birds, and plants and the management of protected areas. It is not intended for the regulation of industrial emissions, which are instead governed by the Air Act and the Environment Protection Act. Each piece of environmental legislation in India has a specific and distinct primary purpose, such as water pollution control or forest conservation. Correctly identifying these roles is essential for understanding the multi-layered regulatory framework that manages the country's diverse environmental challenges.

189. (B) 1, 2, 3, 4, and 5`
In 2016, India's Ministry of Environment undertook a major regulatory update by notifying five comprehensive sets of waste management rules. These rules for solid, electronic, bio-medical, plastic, and construction waste each address specific challenges and promote sustainable practices like waste segregation and recycling. They also introduced key principles like extended producer responsibility for certain products. Together, these rules form a modernized and integrated framework for managing diverse waste streams, aiming to improve resource recovery and protect both public health and the environment across various sectors.

190. (D) A voluntary framework that helps an organization achieve its environmental goals through consistent control of its operations.
An environmental management system, as defined by the ISO 14000 series, is a voluntary and structured framework that helps organizations manage their environmental responsibilities. It provides a systematic approach for identifying, monitoring, and controlling environmental impacts, promoting a culture of continuous improvement and pollution prevention. By implementing an EMS, an organization can enhance its environmental performance, ensure regulatory compliance, and demonstrate its commitment to sustainability. It is a management tool that integrates environmental considerations into daily operations, helping organizations

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were issued under the broad powers conferred by the Environment Protection Act of 1986. This parent Act serves as an umbrella legislation, authorizing the central government to make rules and take measures for protecting and improving environmental quality. By using these powers, the government could mandate the process of environmental assessment for certain categories of projects, ensuring that ecological concerns are systematically integrated into the national developmental planning and project approval process across various sectors.

205. (C) Outline the practical actions to mitigate and manage the environmental impacts identified in the EIA.
The primary purpose of an Environmental Management Plan is to provide a detailed roadmap for managing the environmental impacts of a project. It outlines the specific and practical mitigation measures, monitoring protocols, and institutional arrangements that will be implemented during construction and operation. By translating the findings of the impact assessment into concrete actions, the EMP ensures that the commitments made to protect the environment are effectively carried out. This plan is essential for minimizing ecological harm and ensuring that the project remains in compliance with environmental standards.

206. (A) Both Statement I and Statement II are true.
The 1972 Stockholm Conference and the 1992 Rio Summit are two landmark events in global environmental history. Stockholm was the first major international conference to focus on environmental issues on a global scale, leading to the creation of UNEP. Twenty years later, the Rio Summit was the first global gathering to center its discussions on the concept of sustainable development, producing Agenda 21 and several key conventions. Both conferences played a critical role in shaping international environmental policy and fostering global cooperation toward protecting the planet and promoting sustainable growth.

207. (C) To grant ownership of all river water to the private sector.
The National Water Policy of 2002 aims to provide a standardized national framework for the sustainable management of water resources. Its objectives include prioritizing drinking water for humans and animals and providing for the holistic planning and development of water resources. It does not aim to grant private ownership of all river water. Instead, the policy emphasizes that water is a scarce and precious resource that must be managed as a public good, with community participation and the integration of environmental concerns being central to its governance.

208. (A) Determining if a particular chemical or physical agent has the potential to cause harm.
Hazard identification is the initial and essential step in the risk assessment process. It involves a systematic scientific evaluation to determine whether a specific substance, chemical, or physical agent has the potential to cause adverse effects in humans or the environment. This phase identifies the nature of the potential harm without yet quantifying the level of risk. By pinpointing potential threats, hazard identification provides the foundational information needed for subsequent steps, such as dose-response assessment and exposure analysis, ensuring that overall risks are accurately characterized and managed.

209. (B) P-2, Q-1, R-4, S-3`
Indian environmental legislation addresses diverse concerns through specialized laws and rules. The Motor Vehicle Act regulates vehicular emission standards to protect air quality, while the Indian Forest Act manages the transit of forest produce. Hospital waste is handled under the Bio-Medical Waste Management Rules, and the e-waste Rules introduce the principle of extended producer responsibility for managing discarded electronics. This categorical approach ensures that different environmental challenges, from urban pollution to forest administration and hazardous waste disposal, are managed through a coordinated and effective regulatory framework.

210. (D) 1, 2, 3, and 4`
The Wildlife Protection Act of 1972 is a comprehensive law that protects diverse fauna and flora across India. It establishes various schedules that provide different levels of protection to specified species and prohibits the trade in wildlife products. Significant amendments, such as the one in 1991, added

movement procedures, requiring the consent of the receiving country before any hazardous waste can be shipped. By promoting the environmentally sound management of hazardous wastes at their source, the convention aims to protect human health and the environment globally.

198. (B) Environmental Impact Assessment
Environmental impact assessment is a predictive tool primarily used during the planning stages of a project, including both the pre-construction and pre-operational phases. Its goal is to identify and evaluate potential environmental consequences before a project is implemented, allowing for the integration of mitigation measures into the design. By assessing the foreseeable impacts early on, EIA ensures that environmental concerns are considered in decision-making and that developmental activities are conducted in a more sustainable manner. This proactive approach contrasts with tools used for monitoring or auditing existing operations.

199. (D) 4 only
Among the listed bodies, only the Global Environment Facility (GEF) functions as a financing mechanism for major environmental conventions. It provides grants and funding support for projects related to biodiversity, climate change, and other global environmental concerns. In contrast, UNEP coordinates environmental activities, IPCC assesses climate science, and IGBP focuses on research, none of which primarily serve as funding mechanisms.

200. (A) Both A and R are true and R is the correct explanation of A.
The Air Prevention and Control of Pollution Act empowers State Pollution Control Boards to declare specific regions as air pollution control areas. This provision allows for the implementation of focused regulatory measures and stricter emission standards in areas that have high levels of pollution or are ecologically sensitive. By concentrating enforcement efforts in these designated zones, the boards can more effectively manage and reduce air contamination from industrial and other sources. This targeted approach is essential for protecting public health and improving overall air quality in the most affected regions.

201. (C) Water (Prevention and Control of Pollution) Act - 1974
The Water Prevention and Control of Pollution Act was enacted in 1974, representing the first major piece of environmental legislation in modern India. It established the institutional framework for pollution control, including the creation of the Central and State Pollution Control Boards. In contrast, the Wildlife Protection Act was passed in 1972, the Environment Protection Act in 1986, and the Air Act in 1981. Correctly matching these laws with their enactment years is essential for understanding the progressive development of the national regulatory framework for environmental protection and management.

202. (B) The Biological Diversity Act, 2002
The concept of equitable benefit sharing is a key and distinctive component of the Biological Diversity Act of 2002 This provision ensures that the benefits derived from the commercial or research use of genetic resources and traditional knowledge are shared fairly with the local communities who have conserved these resources. By recognizing the rights of indigenous and local populations, the Act promotes social justice and provides incentives for biodiversity conservation. This legal mechanism ensures that the country's diverse biological heritage is used sustainably and that its benefits are equitably distributed.

203. (D) Extended Producer Responsibility
A key feature of the Batteries Management and Handling Rules is the principle of extended producer responsibility. This principle mandates that manufacturers and importers are responsible for the collection and safe recycling of used lead-acid batteries. By placing this obligation on the producers, the rules aim to ensure that hazardous lead is recovered and recycled in an environmentally sound manner, preventing soil and water contamination. This approach encourages manufacturers to develop efficient collection systems and promotes the sustainable management of toxic materials throughout their entire lifecycle.

204. (C) The Environmental (Protection) Act, 1986
The 2006 Environmental Impact Assessment Notification and its subsequent amendments

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balance economic growth with ecological protection.

191. (A) Protecting the stratospheric ozone layer.
The primary focus of the 1987 Montreal Protocol is the protection of the stratospheric ozone layer. This successful international treaty coordinates global efforts to phase out the production and consumption of ozone-depleting substances, such as chlorofluorocarbons. By establishing legally binding schedules for the elimination of these chemicals, the protocol has led to a significant recovery of the ozone layer, which protects the Earth from harmful ultraviolet radiation. This landmark agreement demonstrates the power of science-based international cooperation in addressing critical global atmospheric challenges.

192. (B) 1988
The Water Prevention and Control of Pollution Act, originally passed in 1974, underwent a significant amendment in 1988. This update was designed to strengthen the powers of the pollution control boards and improve the enforcement of water quality standards. The amendment introduced stricter penalties for non-compliance and allowed authorities to take more direct action against polluting industries, such as closing them down or cutting off essential services. These changes reflected a growing recognition of the need for a more robust regulatory framework to effectively protect the country's water resources.

193. (B) Johannesburg Plan of Implementation
The primary outcome of the 2002 World Summit on Sustainable Development in Johannesburg was the Johannesburg Plan of Implementation. This document focused on practical actions and targets to revitalize the global commitment to sustainable development and the goals of Agenda 21. It emphasized key areas such as poverty eradication, sustainable consumption and production, and the protection of the natural resource base. The plan highlighted the importance of partnerships and international cooperation in addressing the interlinked social, economic, and environmental challenges facing the global community in the twenty-first century.

194. (A) Both Statement I and Statement II are true.
Life-cycle analysis and environmental auditing are two distinct and essential tools for environmental management. LCA takes a comprehensive approach, evaluating the environmental impacts of a product from raw material acquisition all the way through to final disposal. In contrast, an environmental audit is a systematic and objective evaluation of an existing facility's performance against established criteria and regulatory requirements. While LCA focuses on the product's entire journey, auditing focuses on verifying current operational compliance and identifying areas for improving the environmental performance of a specific industrial site.

195. (C) Hazardous substances
The Public Liability Insurance Act of 1991 was specifically enacted to provide immediate financial relief to victims of accidents involving hazardous substances. It mandates that owners of enterprises handling such materials must take out insurance policies to cover potential liabilities. The Act is based on the principle of no-fault liability, meaning compensation can be provided without the need to prove negligence on the part of the owner. This ensures that persons affected by industrial accidents, such as chemical leaks or releases, can receive swift and necessary support for their recovery.

196. (D) Including provisions for the protection of specified plants.
The 1991 amendment to the Wildlife Protection Act was a significant expansion of the national legal framework for conservation. It introduced provisions specifically for the protection of rare and endangered plant species, recognizing their critical importance to ecosystem health and biodiversity. This amendment allowed the government to regulate the collection and trade of these plants, ensuring that the country's diverse flora receives the legal protection needed for its long-term survival. By including plants, the Act took a more holistic approach to conserving the entire natural biological heritage of the country.

197. (D) Basel Convention
The Basel Convention is an international treaty that focuses on controlling the transboundary movement and disposal of hazardous wastes. It was adopted to prevent developed countries from dumping their hazardous waste in developing nations that lack the capacity to manage it safely. The convention establishes strict notification and

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protections for specified plants. The Act is enforced by the forest department and provides the legal basis for managing protected areas like National Parks. Together, these provisions ensure the long-term conservation of the country's rich and varied natural heritage.

211. (D) Montreal Protocol
The Montreal Protocol is an international treaty specifically designed to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances. These substances, such as chlorofluorocarbons, cause the thinning of the ozone layer, leading to increased ultraviolet radiation reaching the Earth's surface. By establishing legally binding schedules for the elimination of these chemicals, the protocol has become one of the most successful international environmental agreements, demonstrating the power of coordinated global action in addressing critical atmospheric challenges and protecting human health.

212. (A) Cradle-to-grave analysis
Life-cycle assessment is often referred to as a cradle-to-grave analysis because it evaluates the environmental impacts of a product from its initial raw material extraction all the way through to its final disposal. This comprehensive approach considers every stage of a product's life, including manufacturing, transportation, and usage. By providing a holistic view of the environmental footprint, life-cycle assessment helps organizations identify opportunities for reducing resource consumption and pollution. It is a critical tool for promoting sustainable production and consumption patterns and improving overall environmental performance.

213. (D) Check the indiscriminate diversion of forest lands for non-forest purposes.
The primary objective of the Forest Conservation Act of 1980 is to prevent the indiscriminate diversion of forest land for industrial or other non-forest uses. The Act recognizes the essential ecological services provided by forests and mandates that any proposal to use forest land for other purposes must obtain prior approval from the central government. This centralized oversight ensures that forest conservation is prioritized and that developmental needs are balanced against the need to maintain the country's forest cover and protect biodiversity and vital ecosystem functions.

214. (B) It empowers the Central Government to take all measures necessary to protect the environment.
The Environment Protection Act of 1986 is an umbrella legislation that grants the central government broad and comprehensive powers to protect and improve environmental quality. Enacted following the Bhopal Gas Tragedy, it allows the government to set national standards, manage hazardous substances, and coordinate the activities of various specialized authorities. This Act provides the legal framework for a holistic approach to environmental management, ensuring that the government has the necessary tools to address diverse ecological challenges and fill gaps in earlier, more specific legislation.

NODIA

215. (A) The conservation and sustainable use of wetlands.
The Ramsar Convention is an international treaty dedicated to the conservation and sustainable use of wetlands and their resources. It recognizes the vital ecological functions of wetlands and encourages parties to promote their wise use. By designating significant wetlands as Wetlands of International Importance and implementing national policies for their protection, the convention contributes to global biodiversity conservation and the long-term well-being of communities that depend on wetland ecosystems. This intergovernmental treaty provides the framework for international cooperation in protecting these productive and sensitive habitats.

216. (A) Both A and R are true and R is the correct explanation of A.
The Solid Waste Management Rules of 2016 mandate waste segregation at the source, which is a critical step for efficient waste management. By requiring households and businesses to separate their waste into biodegradable, non-biodegradable, and hazardous categories, the rules facilitate more effective recycling and composting. This reduction in mixed waste ensures that more materials can be recovered and reused, ultimately decreasing the volume of waste sent to landfills. Segregation at the source

The phrase amendments from time to time in the context of Coastal Regulation Zone rules implies that the regulations are dynamic and subject to periodic review. As new scientific knowledge becomes available or as the needs and challenges of coastal areas evolve, the government modifies the rules to ensure they remain effective and relevant. This flexible approach allows for the integration of better environmental protection measures and the balancing of developmental needs with the conservation of fragile coastal ecosystems, ensuring that the regulatory framework remains responsive to changing ecological and social conditions.

243. (A) Global Environment Facility (GEF)
The Global Environment Facility serves as the primary financial mechanism for both the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity. It provides grants and concessional funding to developing countries to help them implement projects that address global environmental issues and meet their obligations under these treaties. By directing financial resources toward biodiversity conservation and climate change mitigation, the GEF plays a critical role in supporting international efforts to promote sustainable development and protect the planet's essential life-support systems in countries that lack the necessary financial resources.

244. (A) Noise
The Air Prevention and Control of Pollution Act was amended in 1987 to include noise within the definition of air pollution. This recognition of noise as a significant pollutant was a landmark change, allowing pollution control boards to set ambient noise standards and regulate excessive noise from various industrial and urban sources. By expanding the legal framework of the Air Act, the government ensured that noise pollution could be monitored and controlled, recognizing its harmful effects on human health, well-being, and the natural environment, and integrating noise management into broader environmental protection efforts.

245. (A) Earth Summit at Rio de Janeiro, 1992
Agenda 21 is a comprehensive and voluntary blueprint for action for sustainable development adopted at the 1992 Earth Summit in Rio de Janeiro. It provides a global, national, and local framework for organizations, governments, and major groups to address the environmental and developmental impacts of human activities. By outlining strategies for poverty eradication, resource management, and social equity, Agenda 21 has shaped global policy and influenced sustainable development initiatives around the world. Its adoption at the Rio Summit represented a significant international commitment to achieving a more sustainable and resilient future for the planet.

246. (A) Both A and R are true and R is the correct explanation of A.
The Public Liability Insurance Act of 1991 was enacted to ensure immediate financial relief for victims of accidents involving hazardous substances. It is based on the principle of no-fault liability, meaning that compensation can be provided without the need for victims to prove negligence on the part of the owner. This ensures that persons affected by industrial accidents can receive swift and necessary support for their recovery. The Act mandates that owners of facilities handling such materials must take out insurance policies, providing a reliable and efficient mechanism for providing relief in the event of an accident.

247. (A) The Polluter Pays principle.
The National Environmental Policy of 2006 explicitly adopts the polluter pays principle as a core guiding principle for environmental management in India. This principle states that those who cause environmental pollution should bear the costs of managing it and repairing any damage done. By internalizing environmental costs, the policy encourages industries and individuals to adopt cleaner technologies and practices. This approach promotes both environmental protection and economic efficiency, ensuring that the burden of pollution is not shifted to the public or the environment, but remains the responsibility of those who cause it.

248. (A) Propose a set of mitigation, management, monitoring, and institutional measures to eliminate, offset, or reduce adverse environmental impacts.

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in India. It emphasizes the maintenance of environmental stability and ecological balance while ensuring that the basic needs of local communities for fuel and fodder are met. This policy document serves as a roadmap for the state and central government agencies, guiding their actions and the formulation of laws related to forest protection and sustainable resource use. It reflects a commitment to long-term ecological sustainability over short-term commercial gains.

224. (A) Both Statement I and Statement II are true.
The Basel Convention and the Montreal Protocol are two major international environmental agreements addressing distinct global challenges. The Basel Convention focuses on controlling the transboundary movement and disposal of hazardous wastes to prevent environmental contamination and protect human health. In contrast, the Montreal Protocol is dedicated to protecting the stratospheric ozone layer by phasing out ozone-depleting substances. Both agreements represent successful international cooperation and demonstrate the importance of coordinated global efforts in managing hazardous materials and protecting essential atmospheric systems for the well-being of the entire planet.

225. (C) The channelization of e-waste to ensure environmentally sound management.
Under the e-waste Management Rules of 2016, extended producer responsibility means that producers of electronic equipment are responsible for the collection and proper management of their products at the end of their useful life. This involves setting up collection centers and ensuring that discarded electronics are channelized to authorized dismantlers or recyclers. By holding producers responsible, the rules aim to create a structured and sustainable system for managing electronic waste, preventing hazardous materials from contaminating the environment while promoting the recovery and reuse of valuable materials.

226. (A) The creation of the United Nations Environment Programme (UNEP).
A historic and significant outcome of the 1972 Stockholm Conference on the Human Environment was the creation of the United Nations Environment Programme. As the leading global environmental authority, UNEP was established to set the global environmental agenda, coordinate international efforts, and advocate for the protection of the planet. Its creation marked a major step in the institutionalization of global environmental governance, providing a central forum for nations to collaborate on addressing complex challenges such as pollution, climate change, and the conservation of diverse natural resources.

227. (A) To identify the most significant issues and impacts that need to be addressed in the EIA study.
In the context of an environmental impact assessment, scoping is a critical early stage used to identify the most significant issues and impacts that require detailed investigation. By focusing on the key environmental concerns, scoping ensures that the assessment process is efficient and that resources are directed toward the most important potential consequences. This stage also involves consulting with stakeholders and local communities to ensure that their perspectives and concerns are included in the scope of the study, promoting a more thorough and inclusive assessment.

NODIA

228. (B) The Convention on Biological Diversity (CBD)
The Biological Diversity Act of 2002 was specifically enacted in India to give effect to the provisions of the international Convention on Biological Diversity. The Act provides a comprehensive framework for the conservation of biological resources, their sustainable use, and the fair and equitable sharing of benefits arising from genetic resources and traditional knowledge. By fulfilling its obligations under the CBD, India has established a legal and institutional system that recognizes the importance of biodiversity and ensures that its utilization contributes to both environmental protection and social justice.

229. (A) P-4, Q-1, R-3, S-2`
Major international environmental conferences are each associated with key themes and outcomes that have shaped global policy. The Rio Summit produced Agenda 21, while the Johannesburg Summit resulted in a comprehensive Plan of Implementation for sustainable development. The Stockholm Conference was themed Only One Earth, marking the start of global environmental

merely reacting to them later. This proactive stance ensures that projects are designed to be environmentally sound, balancing human development needs with the necessity of conservation.

255. (C) To verify the assessment's objectivity and compliance with standards.
The review of environmental assessments serves as a critical verification step to uphold the quality of the process. It ensures the evaluation is objective, comprehensive, and strictly adheres to the established regulatory standards before any project clearance is granted. This scrutiny maintains the integrity of the predictive process, confirming that all potential ecological impacts are accurately and fairly documented.

256. (B) To assess environmental impacts across all stages of a product or project's existence.
Advanced analytical frameworks utilize a cradle-to-grave methodology to evaluate ecological footprints. This approach examines the environmental effects associated with every phase, including raw material extraction, manufacturing, distribution, and eventual disposal. By considering the entire duration of a product or project, this analysis provides a comprehensive understanding of its total environmental impact beyond just the immediate site or operation.

257. (D) During the project's operational phase to ensure ongoing compliance.
Assessing environmental performance continues well after the initial planning and construction are completed. Periodic evaluations during the operational stage serve to verify that activities remain in compliance with established management plans. These audits check the effectiveness of implemented mitigation measures and provide a feedback loop. This ongoing monitoring is essential for improving environmental management throughout the project life.

258. (A) By monetizing and comparing the economic and environmental costs against the benefits.
Evaluating developmental projects often involves a systematic comparison of projected economic gains against various costs. This methodology extends to the environment by assigning monetary values to ecological impacts and mitigation expenses. By quantifying these factors, the process allows for a structured assessment of whether the overall benefits of a project justify its environmental and economic expenditures over time.

259. (C) It ensures environmental considerations are a continuous and integrated process.
Incorporating environmental considerations is not a singular event but a fundamental, ongoing part of management frameworks. It links the initial impact assessment with subsequent auditing procedures to create a seamless cycle of oversight. This integration ensures that ecological factors remain central to decision-making throughout the lifespan of a project, fostering consistent environmental responsibility and continuous improvement in performance.

260. (A) Examine the EIA report for accuracy and completeness before approval.
The formal evaluation of impact reports functions as a safeguard to ensure the quality of information provided to decision-makers. This procedural review scrutinizes the documentation for thoroughness and precision before any regulatory authorization is granted. By validating the findings, the review ensures that the assessment reflects a true and complete picture of the potential consequences of developmental activities.

261. (D) To provide a voluntary framework for an organization's Environmental Management System.
International standards offer a structured approach for entities wishing to manage their environmental responsibilities systematically. These guidelines are voluntary and help organizations identify, control, and reduce their ecological impacts through a cycle of improvement. By adopting such a system, an organization demonstrates a commitment to sustainable practices and ensures it remains compliant with relevant environmental legislation and requirements.

262. (B) By informing consumers to create market demand for environmentally friendly products.
Market-based instruments use information to influence purchasing decisions and production

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vital life-support systems that forests provide, ensuring the long-term well-being of both people and the environment.

236. (C) A is true but R is false.
Article 51A(g) of the Indian Constitution establishes the protection and improvement of the environment as a fundamental duty of every citizen. While this constitutional provision is significant, fundamental duties are generally not directly enforceable in courts without specific enabling legislation passed by Parliament. Therefore, while citizens have a constitutional obligation to protect the environment, any punishment for its violation depends on the existence of specific laws, such as the Wildlife Protection Act or the Environment Protection Act, which provide the necessary legal tools for enforcement and penalties.

237. (A) An Ecomark label on a soap that indicates it is less harmful to the environment.
An example of an eco-labeling scheme in practice is the Ecomark label found on various consumer products, such as soaps and detergents. This voluntary label informs consumers that a product has met specific environmental criteria and is less harmful to the environment compared to other similar products in its category. By providing clear and reliable information about a product's environmental performance, the Ecomark helps consumers make more sustainable purchasing decisions and encourages manufacturers to adopt greener production methods, promoting environmental responsibility in the marketplace.

238. (D) Statement I is false, but Statement II is true.
The Kyoto Protocol is based on the principle of common but differentiated responsibilities, which places a heavier burden on developed countries for reducing greenhouse gas emissions. While it established binding emission reduction targets for developed nations, it did not set the same binding targets for developing countries during its initial commitment period. This differentiation recognizes that developed countries are historically responsible for the majority of greenhouse gas emissions and have a greater capacity to address climate change. This principle remains a fundamental and often debated aspect of international climate negotiations and agreements.

239. (B) Creating an inventory of the quantity and location of hazardous materials.
Hazard accounting is a technical component of risk assessment that involves creating a detailed inventory of the hazardous materials present at a facility. This includes documenting the specific types, quantities, and locations of these materials. By providing a clear and comprehensive record of potential hazards, this process helps in identifying and characterizing risks, planning for emergency responses, and ensuring that appropriate safety and management measures are in place. It is a foundational step for the safe handling of hazardous substances and for developing effective risk management strategies in industrial settings.

240. (D) 1, 2, 3, and 4`
Major international environmental agreements each address a specific global ecological challenge. The Montreal Protocol successfully coordinates efforts to protect the ozone layer, while the Basel Convention regulates the transboundary movement and disposal of hazardous wastes. The Ramsar Convention focuses on the conservation and wise use of wetlands, and the Kyoto Protocol commits parties to reducing greenhouse gas emissions. Together, these agreements represent a comprehensive and coordinated global effort to protect the environment, conserve vital natural resources, and address the pressing challenges of climate change and chemical pollution.

241. (A) Environmental Impact Statement (EIS)
A detailed report prepared by a consultant to evaluate the environmental consequences of a proposed project, such as a new highway, is called an Environmental Impact Statement. This document provides a comprehensive assessment of potential impacts on air, noise, water, and wildlife and suggests alternatives and mitigation measures. The EIS is a critical part of the decision-making process, ensuring that authorities and the public have a thorough understanding of the project's environmental implications before approval is granted. It serves as the formal record of the environmental assessment conducted for a specific developmental proposal.

242. (A) Subject to periodic review and modification based on new knowledge and changing needs.

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is therefore essential for promoting sustainability and improving municipal waste management systems.

217. (B) An Environmental Audit
An environmental audit is a systematic and periodic check of an organization's operations against established environmental laws and its own internal policies. Unlike impact assessments, which are predictive tools for new projects, audits provide an objective evaluation of current and past performance. They identify areas of non-compliance, evaluate the effectiveness of environmental management systems, and help organizations identify opportunities for improving their environmental performance and reducing ecological liabilities. By providing a clear and documented assessment, an audit ensures that organizations are meeting their environmental responsibilities.

218. (C) Standards for vehicular emissions and noise
The provisions of the Motor Vehicle Act of 1988 related to environmental protection primarily focus on regulating pollutants from vehicles. The Act empowers the government to set and enforce standards for vehicular emissions and noise levels, ensuring that motor vehicles do not excessively contaminate the air or contribute to noise pollution. These regulations are an important part of the national effort to improve urban air quality and protect public health. Regular emission checks and certification are mandated to ensure that vehicles continue to meet these essential environmental standards.

219. (A) 1, 2, 3 and 4 only
The primary objectives of an environmental impact assessment are to integrate environmental considerations into project design, predict potential adverse impacts, and propose mitigation measures. Additionally, the process provides a vital platform for public participation in decision-making. By evaluating projects before they begin, EIA ensures that environmental consequences are considered alongside developmental goals. It is not intended to find reasons to reject all projects; instead, it provides a balanced and scientific assessment that helps to ensure that development is sustainable and that significant negative impacts are avoided or minimized.

220. (B) Compare the economic advantages of a project against its economic disadvantages, including monetized environmental impacts.
The primary purpose of a cost-benefit analysis in the context of an environmental assessment is to compare the economic advantages of a project against its disadvantages. This involves assigning monetary values to various impacts, including environmental costs and benefits, such as pollution reduction or resource loss. By providing a common economic basis for comparison, the analysis helps decision-makers evaluate whether a project provides an overall net benefit to society. While challenging for intangible ecological values, it is a standard tool for assessing the economic and environmental sustainability of developmental projects.

221. (B) 42nd Amendment
The 42nd Constitutional Amendment Act of 1976 introduced two significant environmental provisions into the Indian Constitution. Article 48A was added to the Directive Principles of State Policy, imposing a duty on the state to protect and improve the environment. Additionally, Article 51A was introduced, establishing the protection of the environment as a fundamental duty of every citizen. These constitutional changes marked a major turning point, formalizing the shared responsibility of both the state and individuals for ecological conservation and the sustainable management of natural resources.

222. (C) Risk Assessment
Scenarios of exposure are a critical component of the risk assessment process, used to identify the pathways through which a hazard might reach human populations or the environment. This analysis involves identifying the sources of a hazard, the media it travels through, and the potential routes of contact, such as inhalation or ingestion. By developing these scenarios, researchers can estimate the magnitude and duration of potential exposure, which is essential for characterizing the overall risk posed by a substance and for making informed decisions about risk management.

223. (A) National Forest Policy, 1988
The National Forest Policy of 1988 is a foundational document that provides the guiding principles for forest management and conservation

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The primary function of an Environmental Management Plan within an EIA report is to provide a comprehensive set of measures to manage environmental impacts. This includes identifying specific mitigation actions to reduce negative effects, developing monitoring protocols to track environmental quality, and establishing institutional arrangements for implementation. By providing a clear and actionable roadmap, the EMP ensures that the environmental commitments made during the assessment phase are effectively carried out during the project's construction and operation, ensuring that developmental activities are conducted in a more sustainable and environmentally responsible manner.

249. (A) Montreal Protocol – Protection of the ozone layer
A correct matching of an international agreement with its primary objective is the Montreal Protocol and the protection of the stratospheric ozone layer. This successful treaty coordinates global action to phase out ozone-depleting substances. In contrast, the Kyoto Protocol is focused on greenhouse gas reductions, and the Basel Convention deals with the control of transboundary movements of hazardous wastes. The Ramsar Convention specifically targets the conservation of wetlands. Understanding these distinct roles is essential for recognizing how different international treaties work together to address diverse global environmental challenges and promote overall ecological sustainability.

250. (A) The Environment (Protection) Act, 1986
The comprehensive suite of waste management rules notified by the Indian government in 2016 was promulgated under the authority of the Environment Protection Act of 1986. This parent Act serves as an umbrella legislation, providing the central government with broad powers to make rules for protecting and improving the environment. By using these powers, the government could establish updated and specialized regulations for different types of waste, ensuring a more unified and effective approach to environmental management and resource recovery across various industrial and domestic sectors.

251. (B) To provide decision-makers with information to integrate environmental factors into project planning.
The systematic process of predicting environmental consequences aims to offer a holistic perspective to authorities. By evaluating potential impacts before finalized project authorization, this approach ensures that environmental factors are thoroughly embedded in the design phase. This proactive strategy allows for informed decision-making that prioritizes long-term ecological health alongside developmental goals within the broader planning and design framework.

252. (A) The Environmental Management Plan (EMP).
The administrative framework includes a specific plan designed to manage anticipated environmental risks. This document details necessary mitigation measures and systematic monitoring programs to handle adverse effects. By outlining institutional arrangements and required actions, it provides a practical roadmap for maintaining environmental quality. This component ensures that commitments to reduce ecological damage are effectively implemented and continuously tracked throughout.

253. (C) The EIS documents the impacts, while the EMP proposes solutions to manage them.
Environmental assessments involve two distinct but complementary functions within the reporting process. One part serves as a detailed documentation of the findings regarding potential impacts. The other part focuses on operationalizing the response by proposing specific management strategies and mitigation efforts. Together, they bridge the gap between identifying environmental risks and implementing the necessary actions to address those risks.

254. (D) Encouraging proactive prevention of environmental harm through planning and mitigation.
Promoting sustainable development requires a forward-looking approach that addresses environmental degradation at its source. By emphasizing early planning and the integration of mitigation strategies, the process seeks to prevent negative consequences rather than

NODIA

potential hazards, followed by quantifying those hazards. Subsequent steps involve analyzing how populations might be exposed to these risks and then characterizing the overall threat level. This ordered sequence allows for a comprehensive understanding of risks before management decisions are made.

271. (C) A directive principle guiding the State to protect the environment.
Constitutional provisions in India establish the foundational philosophy for environmental governance. Certain articles act as guiding principles that direct the government to strive for the protection and improvement of the natural world. While these are not punishable offenses themselves, they serve as a mandate for the State to develop laws and policies that safeguard forests, wildlife, and the environment.

272. (B) Defines the protection of the natural environment as a fundamental duty of citizens.
Environmental protection is framed not only as a state responsibility but also as a civic obligation. The Constitution enumerates specific duties for every individual, highlighting the importance of protecting the natural environment, including forests, lakes, and rivers. This provision creates a legal and moral basis for public participation and individual accountability in maintaining the ecological health of the nation.

273. (D) To regulate the diversion of forest areas for other uses.
Specific legislation was enacted to address the significant challenge of deforestation and the loss of biodiversity. The primary goal of this law is to control and regulate the process by which forest land is converted for non-forest activities. By requiring formal oversight for such diversions, the statute ensures that forest resources are preserved and managed in a sustainable manner.

274. (A) Establishment of pollution control boards at central and state levels.
Targeted environmental laws focusing on water and air quality created a common institutional structure for regulation. These acts led to the formation of specialized boards at both the national and regional levels. These bodies are responsible for monitoring environmental quality and enforcing pollution control standards, providing a statutory basis for the management of these vital natural resources across the country.

275. (C) Legislative manifestations of the principles laid out in the Constitution.
India's various environmental acts and rules are deeply rooted in the supreme legal document of the nation. They serve as the practical implementation of the broad environmental mandates and duties established within the Constitution. These laws provide the specific regulatory tools and enforcement mechanisms needed to fulfill the constitutional vision of protecting the environment and safeguarding the country's natural heritage.

276. (A) Because it provides a broad, over arching framework and empowers the government to create specific rules.
Legislation described as an umbrella provides a comprehensive, high-level structure that facilitates the coordination of various specialized environmental laws. It empowers the national government to formulate specific regulations and guidelines addressing diverse environmental issues without replacing existing statutes. This broad scope allows for flexible regulatory responses to emerging challenges, ensuring a unified approach to national environmental governance and protection.

277. (D) The Environmental (Protection) Act, 1986.
Specific regulations managing modern challenges like plastic or bio-medical waste are not independent laws. Instead, they derive their legal validity and authority from a primary, over arching act. This parent legislation provides the necessary enabling powers for the government to notify detailed rules and procedures, allowing for targeted management of specific waste streams within a consistent legal framework.

278. (B) The EPA, 1986, serves to coordinate and fill gaps left by the earlier acts.
The environmental legal system consists of multiple acts that address different aspects of pollution. A major piece of legislation functions as an overarching framework that integrates these various laws. It does not replace earlier statutes focused on air or water; rather, it coordinates the activities of different authorities and addresses

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methods. By highlighting the environmental credentials of specific goods, these schemes allow consumers to identify products that are less harmful to the planet. This increased awareness generates market preference for sustainable options, which in turn encourages manufacturers to adopt greener production processes to meet the evolving consumer demand.

263. (C) Voluntary system standard versus mandatory legal requirement.
Environmental governance involves both optional frameworks and compulsory regulations. Some systems are adopted by organizations of their own accord to improve performance and manage impacts systematically. In contrast, other legal instruments are mandated by national law, requiring specific projects to undergo formal clearance processes. This distinction highlights the difference between industry-led initiatives for excellence and state-enforced requirements for compliance.

264. (D) Planning, implementation, review, and continual improvement.
Effective management systems rely on a recurring cycle of activities to ensure long-term effectiveness. This process begins with setting objectives and follows with the execution of those plans. Subsequent evaluations allow for the review of performance against the original goals. This feedback loop is designed to facilitate constant advancement, ensuring that environmental management evolves and improves over time.

265. (A) Influencing organizational and consumer behavior towards sustainability.
Both voluntary management standards and product labeling initiatives aim to shift behaviors toward greater environmental responsibility. By providing structured frameworks for companies and transparent information for the public, these tools encourage more sustainable choices. The shared goal is to alter production and consumption patterns, ultimately reducing the overall ecological footprint of industrial activities and individual consumer habits.

266. (B) Identifying the potential of an agent to cause harm.
Formal assessment of ecological or health hazards begins with determining if a specific physical or chemical agent possesses the inherent capacity to cause harm. This foundational stage identifies existing threats before quantification or exposure analysis occurs. Establishing whether an agent is potentially hazardous is essential for steering the subsequent technical evaluations and management strategies required for comprehensive environmental protection.

267. (B) Risk Characterization.
Synthesizing data on hazards and exposure is a crucial step in understanding the overall threat level. This process integrates information regarding the nature of the hazard with details on how populations are exposed to it. The resulting evaluation estimates the likely incidence and severity of adverse effects, providing a comprehensive picture of risk that informs future management.

268. (A) The process of deciding on and implementing control measures.
While assessment focuses on identifying and quantifying threats, the management phase involves active decision-making. This stage includes evaluating various response options and selecting the most appropriate regulatory or non-regulatory measures to mitigate identified risks. It balances scientific findings with economic, social, and political factors to implement effective controls that protect human health and the broader environment.

269. (C) The pathways and duration of contact between a population and a hazard.
Understanding the context in which a hazard interacts with its surroundings is vital for accurate risk evaluation. This analysis examines the specific ways that human populations or ecosystems come into contact with a threatening agent. It considers factors such as the frequency, duration, and various pathways of contact, providing the necessary data to determine the intensity of potential exposure.

270. (D) Hazard Identification → Hazard Accounting → Scenarios of Exposure → Risk Characterization.
The systematic evaluation of environmental risk follows a logical progression of activities to ensure thoroughness. It begins with identifying

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cooperation. Finally, the Rio+20 conference produced The Future We Want, reaffirming global commitments to sustainability. Together, these events represent the progressive evolution of international environmental governance and the ongoing effort to balance developmental needs with ecological protection.

230. (A) Everyone who generates construction and demolition waste.
The Construction and Demolition Waste Management Rules of 2016 have a wide application, applying to everyone who generates waste from building or demolition activities. This includes individual homeowners, large developers, and government agencies. The rules place a duty on all waste generators to segregate waste into different streams and ensure it is deposited at designated collection centers or processing facilities. By covering all sources of construction debris, the rules aim to reduce illegal dumping and promote the recycling and reuse of materials, minimizing the environmental impact of urban growth.

231. (B) Environmental management
The ISO 14000 family of international standards is primarily focused on environmental management. These voluntary standards provide a structured framework for organizations to identify, manage, monitor, and control their environmental issues in a holistic and systematic way. By implementing these standards, organizations can improve their environmental performance, ensure compliance with environmental laws, and demonstrate their commitment to sustainability to stakeholders. The standards focus on processes and continuous improvement, helping organizations of all sizes and sectors reduce their ecological footprint and promote a more sustainable way of operating.

232. (A) 3, 1, 2, 4`
India notified several comprehensive sets of waste management rules in 2016, addressing different types of waste. When these rules are arranged alphabetically by their primary subjects, the Bio-Medical Waste Management Rules appear first. They are followed by the e-waste Management Rules, then the Plastic Waste Management Rules, and finally the Solid Waste Management Rules. This sequence provides an organized way to list the various specialized regulations introduced to strengthen the national framework for waste management, resource recovery, and the protection of public health and the environment.

233. (A) A set of eight time-bound development goals.
The main contribution of the 2000 United Nations Millennium Summit was the establishment of the Millennium Development Goals. These eight time-bound and measurable goals were designed to address critical global issues such as poverty, hunger, disease, and environmental sustainability. By providing a clear and shared framework for action, the MDGs mobilized international efforts and resources toward achieving specific developmental targets by 2015. The summit represented a landmark global commitment to improving human well-being and protecting the environment, setting the stage for subsequent global developmental initiatives and cooperation.

234. (B) The EIA Notification, 2006 issued under the Environment (Protection) Act, 1986
In India, the requirement for prior environmental clearance for certain categories of projects is mandated by the 2006 Environmental Impact Assessment Notification. This notification was issued under the legal authority of the Environment Protection Act of 1986, which serves as an umbrella legislation for environmental management. By requiring an assessment of potential impacts before a project begins, the notification ensures that environmental concerns are systematically integrated into the project approval process. This proactive approach is essential for identifying and mitigating ecological harm and promoting more sustainable developmental practices across the country.

235. (A) Ensure environmental stability and maintain ecological balance.
The primary objective of the National Forest Policy of 1988 is to ensure environmental stability and maintain ecological balance. This goal recognizes the essential role of forests in soil conservation, water management, and the protection of biodiversity. The policy shifts the focus of forest management from commercial timber extraction to the preservation and restoration of healthy forest ecosystems. By prioritizing ecological stability, the policy aims to protect the country's natural heritage and the

NODIA

any regulatory gaps to ensure comprehensive protection.

279. (C) Confer powers upon the Central Government to create specific environmental regulations.
A primary function of major environmental legislation is to provide the national government with the broad authority necessary to protect environmental quality. This includes the power to make specific rules, set standards, and coordinate the actions of various regulatory bodies. By granting these expansive powers, the law ensures the state can take any measures deemed necessary to prevent environmental degradation.

280. (D) A major industrial disaster, the Bhopal Gas Tragedy.
Significant shifts in environmental policy and law often follow major industrial accidents that highlight weaknesses in existing regulations. In the Indian context, a catastrophic gas leak served as the catalyst for creating more powerful and comprehensive environmental protection legislation. This new law was designed to provide the government with the extensive powers needed to prevent such tragedies and manage environmental risks effectively.

281. (A) Extended Producer Responsibility (EPR).
Modern waste management regulations have introduced concepts that shift the burden of waste handling to those who manufacture the products. This approach makes producers legally responsible for the collection and proper disposal of items once they reach the end of their useful life. This strategy encourages manufacturers to design products that are easier to recycle and less harmful to the environment.

282. (B) Ensure handlers of hazardous substances can provide immediate compensation to accident victims.
Addressing the consequences of industrial accidents involves ensuring that relief is available to those affected without long legal delays. Legislation mandates that entities dealing with dangerous materials must maintain insurance policies. This requirement ensures that financial resources are immediately accessible to provide compensation to victims in the event of an accident, highlighting the importance of accountability in hazardous operations.

283. (B) The Construction and Demolition Waste Management Rules, 2016.
Large quantities of inert waste generated from building and infrastructure projects require dedicated regulatory oversight. Specific rules have been established to manage the collection, segregation, and processing of these materials. By focusing on waste from construction activities, these regulations aim to reduce the burden on landfills and promote the reuse of building materials in a sustainable manner.

284. (A) Including provisions to control pollution from vehicular emissions.
While primarily focused on transportation and road safety, certain statutes also address the environmental impacts of motor vehicles. They include specific provisions designed to regulate and control exhaust emissions, which are a major source of air pollution. By setting standards for vehicle performance, these laws contribute to broader efforts to maintain air quality and protect public health.

285. (C) Create a series of highly specific rules for different waste streams and sectors.
The evolution of environmental governance in India is characterized by the development of specialized regulations for various sectors. Rather than relying on a single general law, the system has branched out into detailed rules for electronic waste, batteries, chemicals, and municipal waste. This targeted approach allows for more effective management of the unique challenges posed by different materials and industries.

286. (D) Policies provide a strategic vision, while acts are legally enforceable mandates.
National governance involves a distinction between long-term strategic documents and statutory laws. Policies articulate a vision, set broad goals, and guide the direction of future initiatives but are typically not enforceable in court. In contrast, acts are legislative documents that create mandatory requirements and carry legal consequences, providing the enforceable framework necessary to implement the broader policy vision.

287. (C) Commercial exploitation to conservation and ecological balance.

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distribution.

Statement II : A platykurtic distribution has a kurtosis value less than 3 (or 0 for excess kurtosis).

Which of the following is correct?

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

17. Which of the following statements about the range as a measure of dispersion is incorrect?

(A) It is simple to calculate and understand.
(B) It uses all the data points in its calculation.
(C) It is highly affected by extreme values.
(D) It is the difference between the maximum and minimum values.

18. The following question consists of two statements, an Assertion (A) and a Reason (R).

Assertion (A) : The second moment about the mean is the variance.

Reason (R) : Moments about the mean are used to describe the shape of a distribution, including its skewness and kurtosis.

Choose the correct option:

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

19. If the concentration of a pollutant is measured as 5 ppm in every sample taken from a site, what would be the standard deviation of these measurements?

(A) 5
(B) 1
(C) 0
(D) 25

20. The measure of asymmetry of a probability distribution about its mean is called:

(A) Kurtosis
(B) Variance
(C) a moment
(D) Skewness

21. Consider the following statements about basic probability theory:

I. The probability of any event is a number between 0 and 1, inclusive.
II. The sum of probabilities of all possible outcomes in a sample space is 1.
III. The probability of an impossible event is 0.
IV. If two events are mutually exclusive, the probability of both occurring is 1.

Which of the above statement(s) is/are correct?

(A) I, II, and III only
(B) I, II, and IV only
(C) II, III, and IV only
(D) I, III, and IV only

22. In hypothesis testing, what does a p-value represent?

(A) The probability that the null hypothesis is a correct representation of reality.
(B) The probability of observing the data, or something more extreme, if the null hypothesis is true.
(C) The probability that the alternative hypothesis constitutes the true state of nature.
(D) The significance level of the test, which is pre-determined by the investigator.

23. Which probability distribution is most appropriate for modelling the number of occurrences of a rare event over a specified interval of time or space, such as the number of mutations in a DNA strand?

(A) Binomial Distribution
(B) Normal Distribution
(C) Log-normal Distribution
(D) Poisson Distribution

24. A correlation coefficient of -0.9 between two variables indicates:

(A) A strong negative linear relationship.
(B) A strong positive linear relationship.
(C) A weak positive linear relationship.
(D) Almost no linear relationship.

25. One-way ANOVA is used to test the difference between:

(A) The means of two independent groups.
(B) The means of two related groups.

NODIA

biodiversity and providing essential services to human populations. The convention encourages the sustainable use of these areas through international cooperation and national action, highlighting their critical role in maintaining the overall health of the planet's ecological systems.

296. (D) It introduced the Clean Development Mechanism (CDM) and binding targets for developed nations.
International climate agreements have evolved to include both mandatory commitments and flexible implementation tools. One significant protocol established legally binding targets for certain nations to reduce their greenhouse gas emissions. It also introduced innovative market-based mechanisms that allowed these countries to meet their obligations through investments in emission-reduction projects abroad, fostering global cooperation in the fight against climate change.

297. (A) To act as the leading body for assessing the science of climate change.
The international community relies on specialized bodies to provide a clear scientific view on complex environmental issues. One such organization is responsible for reviewing and assessing the latest scientific, technical, and socio-economic information related to climate change. Its reports are essential for informing global policy and helping governments understand the risks, potential impacts, and options for mitigation and adaptation.

298. (B) Developed countries to fund emission-reduction projects in developing countries.
Flexible mechanisms in climate treaties allow for cross-border cooperation in reducing atmospheric pollution. This particular arrangement enables industrialized nations to earn emission credits by investing in sustainable projects in other parts of the world. This approach helps these countries meet their binding targets more cost-effectively while simultaneously promoting the transfer of clean technologies and supporting sustainable development in recipient nations.

299. (B) Set the global environmental agenda and promote sustainable development.
The global authority for environmental issues plays a central role in setting priorities and promoting the implementation of sustainable practices worldwide. It serves as an advocate for the environment, facilitating international cooperation and providing leadership on critical ecological challenges. By coordinating various environmental dimensions of development, this agency helps ensure that environmental health remains a core component of global progress.

300. (A) A non-binding accord.
The international gathering held in Copenhagen in 2009 aimed to establish a new legal framework for climate action. However, the final result was a non-binding accord rather than a mandatory successor to previous protocols. While it facilitated high-level political dialogue, it lacked the enforceable emission reduction targets seen in earlier agreements, representing a significant moment in the history of climate diplomacy.

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were true.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

35. The range of values for a Pearson correlation coefficient is:
(A) 0 to 1
(B) 0 to infinity
(C) -1 to +1
(D) -infinity to +infinity

36. In sampling theory, a complete list of all the individuals or objects from which a sample is drawn is called a:
(A) Sample
(B) Population
(C) Quota
(D) Sampling frame

37. Match the items in List I with those in List II based on statistical tests and their applications.
List I:(Statistical Test)
P. t-test
Q. ANOVA
R. Chi-square test
S. Regression
List II:(Application)
1. Comparing means of more than two groups
2. Testing for association between categorical variables
3. Examining the linear relationship between two continuous variables
4. Comparing means of two groups
Choose the correct option from those given below:
(A) P-4, Q-1, R-2, S-3
(B) P-1, Q-4, R-3, S-2
(C) P-4, Q-2, R-1, S-3
(D) P-2, Q-1, R-4, S-3

38. A distribution that is skewed to the right with a long tail is common for environmental contaminant data. Which distribution is often used to model such data?
(A) Normal
(B) Log-normal
(C) Uniform
(D) Binomial

39. The degrees of freedom for a t-test comparing two independent samples with sizes n_1 and n_2 (assuming equal variances) is:
(A) $n_1 + n_2$
(B) $n_1 + n_2 - 1$
(C) $(n_1 - 1) \cdot (n_2 - 1)$
(D) $n_1 + n_2 - 2$

40. Consider the following statements about environmental models:
I. Simple regression models involve one independent variable.
II. Multiple regression models can have several independent variables.
III. Validation is the process of adjusting model parameters to fit the data.
IV. Forecasting involves using a validated model to predict future outcomes.
Which of the above statement(s) is/are correct?
(A) I, II, and III only
(B) I, II, and IV only
(C) II, III, and IV only
(D) I, III, and IV only

41. Leslie's matrix model is specifically designed to:
(A) Model the interaction between two competing species.
(B) Describe the random walk of a dispersing animal.
(C) Predict the growth of a population with a defined age structure.
(D) Estimate the carrying capacity based on resource availability.

42. What does a 95% confidence interval for a population mean imply?
(A) If we repeat the sampling process many times, 95% of the calculated confidence intervals would contain the true population mean.
(B) There is a 95% probability that the true population mean falls within the interval.
(C) 95% of the sample data falls within this interval.
(D) The sample mean is correct in 95% of cases.

NODIA

8. An environmental study on the income of ragpickers in a city reveals a few extremely high incomes. Which measure of central tendency would be the most appropriate to represent the typical income?
(A) Median
(B) Arithmetic Mean
(C) Mode
(D) Harmonic Mean

9. Match the items in List I with those in List II based on scales of measurement.
List I:(Scale of Measurement)
P. Nominal
Q. Ordinal
R. Interval
S. Ratio
List II:(Property)
1. Absolute zero, equal intervals
2. Equal intervals, no true zero
3. Categorization, no order
4. Order or rank
Choose the correct option from those given below:
(A) P-3, Q-4, R-2, S-1
(B) P-3, Q-2, R-4, S-1
(C) P-1, Q-3, R-2, S-4
(D) P-4, Q-3, R-1, S-2

10. All of the following are measures of dispersion EXCEPT:
(A) Kurtosis
(B) Range
(C) Standard Deviation
(D) Quartile Deviation

11. A researcher increases the sample size for a study on air pollution levels. What is the most likely effect on the standard error of the mean?
(A) It increases, suggesting that more data points lead to a higher degree of statistical variability.
(B) It remains unchanged, as it is considered an inherent property of the parent population.
(C) It becomes equal to the standard deviation, representing a direct convergence of parameters.
(D) It decreases, because the sample mean becomes a more precise estimate of the population mean.

12. Consider the following statements regarding statistical variables:
I. A discrete variable can take any value within a given range.
II. The number of bird species in a forest is a continuous variable.
III. The height of a tree is a continuous variable.
IV. A qualitative variable is also known as an attribute.
V. The pH of a soil sample is a discrete variable.
Which of the above statement(s) is/are correct?
(A) I and II only
(B) III and IV only
(C) I, III, and V only
(D) II, IV, and V only

13. The standard deviation of the sampling distribution of a statistic, such as the mean, is known as the:
(A) Variance
(B) Coefficient of variation
(C) Standard error
(D) Range

14. A scientist observes the following number of eggs in 7 bird nests: 2, 3, 4, 4, 5, 4, 3. What is the mode of this dataset?
(A) 2
(B) 3
(C) 5
(D) 4

15. Consider the following steps for calculating the standard deviation of a population:
I. Calculate the mean of the data.
II. Take the square root of the variance.
III. For each data point, find the square of its distance to the mean.
IV. Calculate the average of the squared distances (variance).
Which of the following is the correct chronological order?
(A) I, III, IV, II
(B) III, I, IV, II
(C) I, IV, III, II
(D) IV, I, III, II

16. Consider the following statements regarding statistical distributions:
Statement I : A leptokurtic distribution is more peaked and has heavier tails than a normal

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Forest management strategies have undergone a significant transformation in focus. Earlier approaches often prioritized the economic and commercial value of timber. Modern policies have shifted this emphasis toward long-term conservation, the maintenance of ecological balance, and meeting the needs of local communities. This change recognizes that forests are vital for environmental stability rather than just being sources of industrial raw materials.

288. (B) Seeks to integrate environmental concerns into all developmental activities.
A truly comprehensive environmental policy goes beyond addressing specific types of pollution to influence all aspects of national growth. Its primary aim is to mainstream ecological considerations into every developmental project and sector. By doing so, it ensures that sustainability is not treated as a separate issue but as an integral part of the planning and implementation of all human activities.

289. (D) Promote an integrated and multi-sectoral approach to water management.
Sustainable management of water requires looking at the resource holistically across different uses. National policy emphasizes an integrated approach that considers the needs of various sectors while recognizing water as a finite and precious asset. This strategy aims to standardize information and planning to ensure that water resources are developed and managed in a way that remains sustainable for future generations.

290. (A) To provide a guiding framework for sustainable and environmentally sound action.
National policies serve as essential documents that provide a unified direction for environmental action. They articulate a vision for conservation and sustainable development, informing the creation of laws and government programs. By providing a coherent framework for all stakeholders, these policies ensure that different sectors of society work together toward common goals for protecting natural resources and the environment.

291. (C) The Basel Convention.
Managing the international movement and disposal of hazardous materials is governed by specific global treaties to prevent environmental exploitation. This framework establishes controls on the trans boundary transfer of dangerous wastes, ensuring they are managed in an environmentally sound manner. By regulating these movements, the agreement protects countries from becoming dumping grounds for hazardous by products generated by industrial activities elsewhere.

292. (A) The creation of Agenda-21 as a plan for sustainable development.
The 1992 Earth Summit was a transformative event that produced several critical international instruments. One of the most significant outcomes was a comprehensive plan of action designed to guide global sustainable development into the next century. This document provided a detailed roadmap for addressing environmental, social, and economic challenges through global cooperation and localized efforts at every level of governance.

293. (D) Phasing out substances that deplete the ozone layer.
Protecting the Earth's atmosphere from chemical damage has been the focus of successful international diplomacy. A landmark protocol was established to identify and phase out the production of substances responsible for thinning the ozone layer. By targeting these specific pollutants, the agreement has facilitated the recovery of the atmospheric shield that protects life on Earth from harmful ultraviolet radiation.

294. (B) The launch of global environmental diplomacy.
The first major United Nations conference dedicated to the environment, held in Stockholm, marked the beginning of modern international cooperation in this field. It established the foundations for global environmental diplomacy and led to the creation of important international institutions. This historic event shifted environmental concerns from local or national issues to a central topic of discourse among the global community.

295. (C) Wetlands.
One of the oldest global conservation treaties focuses specifically on the protection of wetlands. These ecosystems are recognized for their international importance in supporting

(C) The means of three or more independent groups.
(D) The variances of two or more independent groups.

26. Which of the following is a key characteristic of the normal distribution?
(A) It is symmetric and bell-shaped.
(B) It is skewed to the right.
(C) It is bimodal.
(D) Its mean is always 0 and standard deviation is always 1.

27. A researcher wants to compare the mean height of a plant species grown in three different types of soil. Which statistical test is the most suitable?
(A) t-test
(B) Chi-square test
(C) Correlation analysis
(D) ANOVA

28. Consider the following statements concerning statistical distributions:
I. The Binomial distribution describes the outcome of 'n' independent trials with only two possible outcomes.
II. The Poisson distribution is characterized by its mean and variance being equal.
III. The standard normal distribution has a mean of 1 and a standard deviation of 0.
IV. The t-distribution becomes more similar to the normal distribution as the degrees of freedom increase.
V. The log-normal distribution is often used for environmental data that are positively skewed.
Which of the above statement(s) is/are correct?
(A) I, II, IV, and V
(B) I, II, IV, and V
(C) II, III, IV, and V
(D) I, III, and V

29. In a simple linear regression model, $Y = a + bX$, what does the coefficient 'b' represent?
(A) The intercept value, representing the expected value of Y when X is equal to zero.
(B) The correlation coefficient that measures the strength of association between X and Y.
(C) The slope, or the change in Y for a one-unit change in X.
(D) The predicted value of the dependent variable Y based on a specific input of X.

30. The Lotka-Volterra model is primarily used to describe:
(A) Population growth in an unlimited environment.
(B) The age structure of a population.
(C) The carrying capacity of a single species.
(D) Predator-prey dynamics.

31. The process of checking an environmental model's performance against a set of data not used in its development is known as:
(A) Validation
(B) Calibration
(C) Forecasting
(D) Interpolation

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32. Consider the following statements regarding errors in hypothesis testing:
Statement I : A Type I error in hypothesis testing occurs when we reject a true null hypothesis.
Statement II : A Type II error in hypothesis testing occurs when we fail to reject a false null hypothesis.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

33. Which of the following is not an assumption of the t-test for independent samples?
(A) The two samples are independent.
(B) The sample sizes of the two groups are equal.
(C) The data in each group are approximately normally distributed.
(D) The variances of the two groups are equal.

34. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : A Chi-square (χ^2) test is used to analyze categorical data.
Reason (R) : It compares the observed frequencies in each category to the frequencies that would be expected if the null hypothesis

CHAPTER 09

Statistical Approaches and Modelling in Environmental Sciences

1. In statistics, a characteristic that can be expressed non-numerically, such as color or gender, is best described as:
(A) a variable
(B) an attribute
(C) a constant
(D) a parameter

2. An environmental scientist records the temperature in Celsius of a lake every hour. What is the scale of measurement for this data?
(A) Interval
(B) Nominal
(C) Ordinal
(D) Ratio

3. Consider the following statements about the arithmetic mean:
I. It is sensitive to extreme values.
II. It is calculated as the sum of all values divided by the number of values.
III. It can be calculated for data on a nominal scale.
IV. The sum of deviations of individual values from the mean is always zero.
Which of the above statements are correct?
(A) I, II, and III only
(B) II, III, and IV only
(C) I, II, and IV only
(D) I, III, and IV only

4. Consider the following statements regarding measures of central tendency:
Statement I : The median is the value that divides a dataset into two equal halves when arranged in ascending or descending order.
Statement II : The mode is always the most suitable measure of central tendency for bimodal distributions.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

5. Which measure of central tendency is defined as the most frequently occurring value in a dataset?
(A) Mean
(B) Median
(C) Mode
(D) Geometric Mean

6. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : The standard deviation is always a non-negative value.
Reason (R) : It is calculated as the square root of the variance, and variance is the average of the squared deviations from the mean, which cannot be negative.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

7. Which of the following statements correctly describes a positively skewed distribution?
(A) The mean is less than the median, and the tail extends to the left.
(B) The mean, median, and mode are all found to be mathematically equal.
(C) The distribution is perfectly symmetric but possesses very heavy tails.
(D) The mean is greater than the median, and the tail extends to the right.

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43. Which of the following is a measure of the peakedness or flatness of a distribution compared to the normal distribution?
(A) Skewness
(B) Standard Error
(C) Interquartile Range
(D) Kurtosis

44. A researcher measures the preference for three types of renewable energy (Solar, Wind, Geothermal) on an ordinal scale (e.g., Rank 1, 2, 3). They want to see if there's a significant difference in preference. Which test is inappropriate?
(A) Friedman Test
(B) One-way ANOVA
(C) Kruskal-Wallis Test
(D) Mann-Whitney U Test (if comparing only two)

45. A kurtosis value of 3 (or an excess kurtosis of 0) is characteristic of which distribution?
(A) Poisson distribution
(B) Binomial distribution
(C) Normal distribution
(D) t-distribution with 1 degree of freedom

46. In the context of the Lotka-Volterra predator-prey model, what happens in the absence of predators?
(A) The prey population declines to extinction.
(B) The prey population stabilizes at the carrying capacity.
(C) The prey population exhibits cyclical oscillations.
(D) The prey population grows exponentially without limit.

47. The F-distribution is a ratio of:
(A) Two variances
(B) Two means
(C) A mean and a variance
(D) Two sample sizes

48. Consider the following statements regarding the Chi-square distribution:
Statement I : The Chi-square (χ^2) distribution is always positively skewed.
Statement II : The shape of the Chi-square distribution depends on its degrees of freedom, and as they increase, it approaches a normal distribution.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

49. An environmental agency wants to determine if there is a linear association between the amount of fertilizer used (kg/hectare) and the concentration of nitrates in groundwater (mg/L). The most appropriate initial statistical analysis would be:
(A) A t-test
(B) A correlation analysis
(C) A Chi-square test
(D) A two-way ANOVA

50. The value that has half of the observations above it and half below it is called the:
(A) Median
(B) Mean
(C) Mode
(D) Mid-range

51. Consider the following scales of measurement:
I. Interval
II. Nominal
III. Ratio
IV. Ordinal
Which of the following is the correct increasing order of information they provide?
(A) II, IV, I, III
(B) II, I, IV, III
(C) I, II, III, IV
(D) IV, II, I, III

52. In a regression analysis, the coefficient of determination (R^2) represents:
(A) The statistical strength and the positive or negative direction of a linear relationship.
(B) The simple probability that the observed results occurred purely as a matter of chance.
(C) The calculated average error present in the predictions made by the statistical model.
(D) The proportion of variance in the dependent

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variable that is predictable from the independent variable(s).

53. If the computed t-statistic in a t-test is greater than the critical t-value at a significance level of $\alpha = 0.05$, the researcher should:
(A) Accept the null hypothesis.
(B) Increase the sample size.
(C) Reject the null hypothesis.
(D) Conclude that the results are not significant.

54. Consider the following statements regarding hypothesis testing:
I. The null hypothesis (H_0) typically represents the status quo or a statement of no effect.
II. The alternative hypothesis (H_1) is what the researcher aims to support.
III. The significance level (α) is the probability of making a Type I error.
IV. A p-value is calculated assuming the alternative hypothesis is true.
V. A test statistic is a standardized value calculated from the sample data.
Which of the above statement(s) is/are correct?
(A) I, II, III, and V
(B) II, III, IV, and V
(C) I, II, IV, and V
(D) I, III, and IV

55. Two-way ANOVA is distinct from one-way ANOVA because it allows for the analysis of:
(A) The calculated means of two separate groups on two different dependent variables.
(B) Non-normally distributed data sets using non-parametric statistical methodologies.
(C) Paired or repeated measures data sets where observations are inherently linked.
(D) The effect of two or more independent variables and their interaction.

56. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : In the Leslie matrix model, the matrix contains age-specific fecundity and survival rates.
Reason (R) : The model projects the total population size but does not provide information about the future age distribution.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

57. A variable that can take on a countable number of values is called:
(A) A continuous variable
(B) A categorical variable
(C) A discrete variable
(D) An attribute

58. Which of the following is a key condition for using a Binomial distribution?
(A) The probability of success is constant for each trial.
(B) The number of trials is infinite.
(C) The trials are dependent on each other.
(D) There are more than two possible outcomes for each trial.

59. Match the items in List I with those in List II based on statistical concepts.
List I:(Concept)
P. Type I Error
Q. Type II Error
R. Significance level (α)
S. Power of a test (1-β)
List II:(Description)
1. Failing to reject a false H_0
2. Probability of a Type I Error
3. Rejecting a true H_0
4. Correctly rejecting a false H_0
Choose the correct option from those given below:
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-1, R-3, S-4

60. The t-distribution is used instead of the normal distribution for hypothesis testing when:
(A) The sample size is very large.
(B) The population standard deviation is unknown and the sample size is small.
(C) The data is categorical.
(D) The population standard deviation is known.

61. Which of the following is not a step in the development of an environmental model?

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(A) Model formulation based on theory and data.
(B) Model calibration using a training dataset.
(C) Disregarding all assumptions to ensure generalizability.
(D) Model validation using an independent dataset.

62. Consider the following statements about measures of dispersion:
I. The variance is the square of the standard deviation.
II. The range is more robust to outliers than the interquartile range.
III. Standard error of the mean decreases as sample size increases.
IV. The coefficient of variation is a relative measure of dispersion.
Which of the above statement(s) is/are correct?
(A) I, II, and III only
(B) I, III, and IV only
(C) II and IV only
(D) I and II only

63. The number of cars passing a certain point on a highway in one hour is an example of a:
(A) Discrete variable
(B) Continuous variable
(C) Ordinal variable
(D) Nominal variable

64. An ecologist is studying the relationship between the density of a plant species and soil moisture. Both variables are measured on a continuous scale. Which statistical method is most appropriate for quantifying the strength and direction of their linear association?
(A) ANOVA
(B) Pearson Correlation
(C) Chi-square test
(D) t-test

65. A Chi-square test for independence is used to determine if there is a significant association between:
(A) A sample mean and a population mean.
(B) Two categorical variables.
(C) Two continuous variables.
(D) The means of three or more groups.

66. Consider the following statements regarding regression models:
Statement I : A regression model can be used for forecasting.
Statement II : A regression model establishes a causal relationship between the independent and dependent variables.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

67. What is the primary purpose of Leslie's matrix model in population ecology?
(A) To model predator-prey cycles.
(B) To determine the genetic diversity of a population.
(C) To project the future size and age distribution of a population.
(D) To map the spatial distribution of a population.

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68. In a perfectly symmetrical distribution, which of the following is true?
(A) Mean > Median > Mode
(B) Mean < Median < Mode
(C) Mean and Mode are equal, but Median is different.
(D) Mean = Median = Mode.

69. The first moment about the mean is always equal to:
(A) The variance
(B) One
(C) Zero
(D) The mean itself

70. The F-test in a one-way ANOVA is used to compare:
(A) The mean of each group to the overall mean.
(B) The variance between groups to the variance within groups.
(C) The sample sizes of the different groups.
(D) The medians of the different groups.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

108. The measure of dispersion that is least affected by extreme values is the:
(A) Range
(B) Interquartile Range (IQR)
(C) Standard deviation
(D) Variance

109. An F-statistic is calculated in ANOVA as:
(A) Mean Square Within / Mean Square Between
(B) Sum of Squares Between / Sum of Squares Within
(C) Mean Square Between / Mean Square Within
(D) Sum of Squares Total / Degrees of Freedom Total

110. Match the distributions in List I with their typical applications in List II.
List I:(Distribution)
P. Binomial
Q. Poisson
R. Normal
S. Log-normal
List II:(Typical Application)
1. Modeling counts of rare events (e.g., accidents)
2. Modeling measurement errors or population characteristics like height
3. Modeling number of successes in n trials (e.g., seed germination)
4. Modeling right-skewed data (e.g., pollutant concentrations)
Choose the correct option from those given below:
(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-1, R-3, S-4

111. The difference between the observed value of the dependent variable and the value predicted by the regression line is called:
(A) The residual
(B) The intercept
(C) The R-squared value
(D) The slope

112. The third moment about the mean is used to measure:
(A) Central tendency
(B) Skewness
(C) Dispersion
(D) Kurtosis

113. Consider the following statements about sampling theory:
I. A simple random sample ensures every individual has an equal chance of being selected.
II. Stratified sampling involves dividing the population into subgroups.
III. Cluster sampling is generally more statistically efficient than simple random sampling.
IV. Convenience sampling is a type of probability sampling.
Which of the above statement(s) is/are correct?
(A) I and II only
(B) I, II, and III only
(C) III and IV only
(D) I, III, and IV only

114. If a regression model for predicting tree height (Y) based on trunk diameter (X) is $Y = 1.2 + 3.5X$, how much is the height expected to increase for every one-unit increase in diameter?
(A) 3.5 units
(B) 1.2 units
(C) 4.7 units
(D) Cannot be determined

115. What type of variable is the brand of a car?
(A) Interval
(B) Ratio
(C) Nominal
(D) Ordinal

116. In the Lotka-Volterra equations for two competing species, what happens if the competition coefficients are zero?
(A) Both species go extinct.
(B) The species coexist in a stable equilibrium.
(C) One species always outcompetes the other.
(D) The species grow logistically, unaffected by

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79. A researcher tests a new fertilizer's effect on crop yield. The null hypothesis is that the fertilizer has no effect. A p-value of 0.02 is obtained. At a significance level of 0.05, what is the correct conclusion?
(A) The result is statistically significant, and we reject the null hypothesis.
(B) The fertilizer has no effect on crop yield.
(C) The result is not statistically significant, and we accept the null hypothesis.
(D) The study needs to be repeated with a larger sample size.

80. A simple linear regression model is expressed as $y = 10.5 + 2.1x$. If the value of the independent variable x is 5, what is the predicted value of the dependent variable y?
(A) 10.5
(B) 21.0
(C) 126
(D) 525

81. Match the terms in List I with the examples in List II based on variable types.
List I:(Term)
P. Discrete Variable
Q. Continuous Variable
R. Nominal Variable
S. Ordinal Variable
List II:(Example)
1. Tree species in a forest
2. Temperature in Kelvin
3. Air quality ranked as poor, average, good
4. Number of rainy days in a month
Choose the correct option from those given below:
(A) P-4, Q-2, R-3, S-1
(B) P-4, Q-2, R-1, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-1, Q-2, R-4, S-3

82. The fourth moment about the mean is used in the calculation of:
(A) Kurtosis
(B) Variance
(C) Skewness
(D) Standard Error

83. Which distribution would be most suitable to model the number of successful trials in a fixed number of independent trials, each with the same probability of success?
(A) Poisson
(B) Normal
(C) Binomial
(D) Log-normal

84. Consider the following statements regarding the normal distribution:
I. It is defined by its mean (μ) and standard deviation (σ).
II. Its skewness is 0 and its kurtosis is 3.
III. Approximately 99.7% of the data lies within one standard deviation of the mean.
IV. The curve is asymptotic to the x-axis.
Which of the above statement(s) is/are correct?
(A) I, II, and IV only
(B) I, II, and III only
(C) II, III, and IV only
(D) I and IV only

85. In a negatively skewed distribution, what is the typical relationship between the mean, median, and mode?
(A) Mean = Median = Mode
(B) Mean > Median > Mode
(C) Mean < Median < Mode
(D) Mode < Mean < Median

86. What is the effect of a very small sample size on a confidence interval for the mean?
(A) It makes the interval narrower.
(B) It makes the interval wider.
(C) It has no effect on the interval width.
(D) It centers the interval at zero.

87. Which test is used to determine if the variances of two populations are equal?
(A) t-test
(B) ANOVA
(C) Chi-square test
(D) F-test

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88. Consider the following statements regarding regression analysis:
Statement I : The process of predicting values outside the range of the observed data using a regression model is called extrapolation.
Statement II : Extrapolation is generally considered more reliable than interpolation.
Which of the following is correct?

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

89. A key component of the Leslie matrix is Fi, which represents:
(A) The survival rate of individuals in age class i.
(B) The total number of individuals in age class i.
(C) The average number of female offspring born to a female of age class i
(D) The probability of an individual moving from age class i to i+1.

90. An ecologist counts the number of individuals of a certain insect species on 100 plants. To test if the observed counts fit a specific theoretical distribution (e.g., Poisson), which test should be used?
(A) Chi-square goodness-of-fit test
(B) t-test
(C) ANOVA
(D) Pearson correlation

91. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : A paired t-test is more powerful than an independent t-test when the data are naturally paired.
Reason (R) : Pairing reduces the effect of extraneous variation between subjects, thereby decreasing the error variance.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

92. The total area under the curve of any continuous probability distribution is equal to:
(A) 0
(B) 1
(C) The mean of the distribution
(D) Infinity

93. Which scale of measurement provides the most information?
(A) Nominal
(B) Ordinal
(C) Ratio
(D) Interval

94. The coefficient of determination (R^2) ranges from:
(A) -1 to +1
(B) 0 to infinity
(C) -1 to 0
(D) 0 to 1

95. In the context of a two-way ANOVA, what is a main effect?
(A) The overall effect of one independent variable on the dependent variable, averaging over the levels of the other independent variable
(B) The interaction effect between the two independent variables.
(C) The effect that has the smallest p-value.
(D) The difference between the observed and predicted values.

96. Which of the following is an assumption of the simple Lotka-Volterra predator-prey model?
(A) The environment has a finite carrying capacity for the prey.
(B) The rate of encounter between predators and prey is proportional to the product of their populations
(C) Predators have an alternative food source.
(D) The prey population has an age structure.

97. If a distribution is platykurtic, it means:
(A) It is more peaked than a normal distribution.
(B) It is flatter than a normal distribution with lighter tails
(C) It is skewed to the left.
(D) It is skewed to the right.

98. The significance level, α, in hypothesis testing, is the probability of:
(A) Committing a Type I error
(B) Correctly rejecting a false null hypothesis.
(C) Committing a Type II error.
(D) Correctly accepting a true null hypothesis.

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99. Which of the following is an example of a linear model?
(A) $Y = a + bX^2$
(B) $Y = a \cdot X^b$
(C) $Y = a + bX$
(D) $Y = \frac{a}{1 + e^{-(b+cX)}}$

100. A researcher investigates the effect of three different irrigation methods (A, B, C) on the yield of a crop. The data collected are the yields from several plots for each method. The appropriate statistical test to use is:
(A) Paired t-test
(B) Simple linear regression
(C) Chi-square test
(D) One-way ANOVA

101. Consider the following steps in hypothesis testing:
I. Collect sample data.
II. State the null (H_0) and alternative (H_1) hypotheses.
III. Compare the test statistic to a critical value or calculate a p-value.
IV. Calculate the test statistic.
V. Make a decision to reject or fail to reject H_0.
Which of the following is the correct logical sequence?
(A) I, II, IV, III, V
(B) II, I, IV, III, V
(C) II, IV, I, V, III
(D) I, IV, II, III, V

102. What does a correlation coefficient of 0 indicate?
(A) A perfect linear relationship.
(B) No linear relationship between the variables
(C) A causal relationship.
(D) The two variables are identical.

103. In sampling, bias refers to:
(A) The natural and expected variability observed when comparing different random samples.
(B) The calculated size of the sample relative to the entire study population.
(C) The numeric difference between the sample mean and the sample median.
(D) The tendency of a sampling method to systematically over- or under-estimate a population parameter.

104. Consider the following statements about environmental modeling:
I. Models are simplifications of reality.
II. A linear model assumes a straight-line relationship between variables.
III. Forecasting is the use of a model to predict past events.
IV. Validation ensures the model is useful for its intended purpose.
V. A multiple regression model has more than one dependent variable.
Which of the above statement(s) is/are correct?
(A) I, II, and IV
(B) II, III, and V
(C) I, III, and IV
(D) I, II, and V

105. Consider the following statements regarding the F-distribution:
Statement I : The F-distribution is a family of distributions, each one defined by two sets of degrees of freedom.
Statement II : The F-statistic can never be negative.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

106. In a Leslie matrix, what do the off-diagonal elements in the first row represent?
(A) Age-specific fecundity rates
(B) Age-specific survival rates
(C) Migration rates between age classes
(D) The probability of death in each age class

107. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : In a two-way ANOVA, it is important to test for an interaction effect before interpreting the main effects.
Reason (R) : The presence of a significant interaction means the effect of one factor is not consistent across all levels of the other factor, making the main effects potentially misleading.
Choose the correct option:

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(C) Continuous and interval scale
(D) Discrete and ratio scale

127. Which of the following is not a basic concept of probability theory?
(A) The probability of two independent events occurring together is the sum of their individual probabilities.
(B) The probability of an event is between 0 and 1.
(C) The sum of probabilities of all possible outcomes is 1.
(D) The probability of an event and its complement sum to 1.

128. Consider the following statements about the components of a Leslie matrix model:
I. The first row contains age-specific fecundity values.
II. The sub-diagonal contains age-specific survival probabilities.
III. All other elements of the matrix are zero.
IV. The matrix is multiplied by a vector representing the total population size.
V. The model assumes a constant environment with no density dependence.
Which of the above statement(s) is/are correct?
(A) I, II, III, and V
(B) II, III, IV, and V
(C) I, II, IV, and V
(D) I, III, and IV

129. The main diagonal of a Leslie matrix, apart from the first element, contains values of zero. Why is this?
(A) These diagonal positions represent the specific mortality rate observed in each age class.
(B) Individuals cannot remain in the same age class from one time step to the next.
(C) It serves as a mathematical convention to simplify the calculation of the projection model.
(D) This is the designated location where migration parameters would be placed if included.

130. A negative value for skewness indicates that:
(A) The tail of the distribution is longer on the left side.
(B) The tail of the distribution is longer on the right side.
(C) The distribution is perfectly symmetric.
(D) The distribution has no mode.

131. Consider the following model development steps:
I. Validation
II. Conceptualization
III. Calibration
IV. Implementation (Coding)
Which of the following is the correct chronological sequence?
(A) II, IV, III, I
(B) I, II, III, IV
(C) II, III, IV, I
(D) III, IV, I, II

132. What does a confidence limit refer to?
(A) The significance level of a hypothesis test.
(B) The maximum possible error in an estimate.
(C) The number of samples required for a study.
(D) The upper and lower boundaries of a confidence interval.

133. If you want to test whether the distribution of an endangered bird species across three different habitats (Forest, Wetland, Grassland) is uniform, which test would be most appropriate?
(A) One-way ANOVA
(B) t-test
(C) Chi-square goodness-of-fit test
(D) Pearson correlation

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134. Match the terms in List I with the symbols or formulas in List II.
List I:(Term)
P. Population Mean
Q. Sample Mean
R. Population Standard Deviation
S. Sample Standard Deviation
List II:(Symbol/Formula)
1. s
2. μ
3. $\bar{x}$
4. σ
Choose the correct option from those given below:
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-4, S-1
(C) P-2, Q-3, R-1, S-4
(D) P-3, Q-2, R-4, S-1

each other.

117. The power of a statistical test is the probability of:
(A) Rejecting H_0 when H_0 is true.
(B) Failing to reject H_0 when H_0 is false.
(C) Rejecting H_0 when H_0 is false.
(D) Failing to reject H_0 when H_0 is true.

118. Which statement about the t-distribution is incorrect?
(A) It is symmetric and bell-shaped, similar to the normal distribution.
(B) As the degrees of freedom decrease, it becomes more like the standard normal distribution.
(C) It has more variance than the standard normal distribution.
(D) It is used when the population standard deviation is unknown.

119. A study compares the average body weight of a fish species in two different lakes. Which statistical test is most appropriate?
(A) Chi-square test
(B) Paired samples t-test
(C) One-way ANOVA with 3 levels
(D) Independent samples t-test

120. Consider the following statements regarding regression analysis:
Statement I : Multiple regression involves one dependent variable and two or more independent variables.
Statement II : Simple regression involves one dependent variable and one independent variable.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

121. For a Poisson distribution, a key characteristic is that:
(A) The mean is always greater than the variance.
(B) The mean is always less than the variance.
(C) The mean is equal to the variance.
(D) The mean is equal to the standard deviation.

122. A researcher surveys 50 people from a village of 500 to estimate the average daily water consumption. In this context, the 50 people constitute a:
(A) Sample
(B) Population
(C) Sampling Frame
(D) Parameter

123. The 'goodness of fit' test is an application of which distribution?
(A) t-distribution
(B) F-distribution
(C) Normal distribution
(D) χ^2-distribution

124. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : The median is a more robust measure of central tendency than the mean.
Reason (R) : The median is less affected by the presence of outliers or extreme values in the data.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

125. The process of using a regression model to predict the dependent variable for a new case with known independent variable values is called:
(A) Validation
(B) Calibration
(C) Forecasting
(D) Hypothesis testing

126. Based on the scenario provided below, answer the following question.
An environmental health officer records the number of asthma cases reported per week in a city. This data is best described as:
(A) Continuous and ratio scale
(B) Discrete and nominal scale

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on a new, independent dataset.
(C) Calculating the regression coefficients using the available data.
(D) Plotting the residuals to check for patterns.

145. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : As sample size increases, the t-distribution approaches the normal distribution.
Reason (R) : With a larger sample, the sample standard deviation becomes a more reliable estimate of the population standard deviation, reducing the uncertainty that the t-distribution accounts for.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

146. For which of the following would a simple linear regression model be most appropriate?
(A) Predicting a student's exam score based on the number of hours they studied.
(B) Predicting crop yield based on rainfall, sunlight, and fertilizer amount.
(C) Comparing the average exam scores of students from three different schools.
(D) Determining if there is an association between gender and passing an exam.

147. All of the following are characteristics of the standard normal distribution EXCEPT:
(A) Mean is 0.
(B) Standard deviation is 1.
(C) It is positively skewed.
(D) The total area under the curve is 1.

148. A measurement scale that allows for ranking but where the differences between ranks are not necessarily equal is:
(A) Nominal
(B) Interval
(C) Ratio
(D) Ordinal

149. In a two-way ANOVA, you can test for:
(A) One main effect and one interaction effect.
(B) Two interaction effects only.
(C) Two main effects and one interaction effect.
(D) One main effect only.

150. In the Lotka-Volterra predator-prey model, the term αxy (where x is prey, y is predator) typically represents:
(A) The growth rate of the prey population.
(B) The rate at which prey are consumed by predators.
(C) The death rate of the predator population due to natural causes.
(D) The carrying capacity of the environment for the prey.

151. Which of the following values could not be a probability?
(A) 0.5
(B) 1.0
(C) 0.0
(D) -0.5

152. Consider the following statements regarding the coefficient of variation:
Statement I : The coefficient of variation is a unitless measure of relative variability.
Statement II : It is calculated by dividing the mean by the standard deviation.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

153. What is the key output of a Leslie matrix multiplication?
(A) The specific numeric value for the population's overall growth rate (λ).
(B) The calculated stable age distribution vector for the long-term population.
(C) A vector representing the number of individuals in each age class at the next time step.
(D) The maximum carrying capacity that the population can sustain in the environment.

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135. The Lotka-Volterra model predicts that, in the absence of prey, the predator population will:
(A) Grow exponentially.
(B) Remain stable.
(C) Switch to an alternative food source.
(D) Decline exponentially to extinction.

136. Consider the following statements regarding variability:
Statement I : The range is a more stable measure of variability than the standard deviation.
Statement II : The standard deviation takes into account every value in the distribution.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

137. Which of the following statements about linear regression is incorrect?
(A) It models a linear relationship between a dependent and one or more independent variables.
(B) The method of least squares is often used to fit the model.
(C) It can be used to establish definitive causality.
(D) It can be used for prediction.

138. The degrees of freedom for a Chi-square test of independence in a contingency table with r rows and c columns is:
(A) (r - 1) * (c - 1)
(B) r * c
(C) r + c - 1
(D) r + c - 2

139. Which of the following approaches is part of developing an environmental model?
(A) Ignoring all existing data to build a purely theoretical model.
(B) Selecting a single complex equation without justification.
(C) Ensuring the model perfectly fits the calibration data, even if it performs poorly on new data.
(D) Validating the model against an independent data set.

140. A researcher finds a correlation of r = +0.85 between daily ice cream sales and the number of drowning incidents. This indicates:
(A) Eating ice cream is a direct cause that results in people drowning in nearby water.
(B) A strong positive association, likely due to a confounding variable like temperature.
(C) A weak positive relationship that possesses almost no practical scientific importance.
(D) The correlation is a pure statistical error and should be disregarded by the researcher.

141. Consider the following statements related to statistical measures:
I. The mean, median, and mode are measures of dispersion.
II. A ratio scale has a true zero point, allowing for meaningful ratios.
III. Standard error measures the variability of a sample statistic.
IV. A leptokurtic distribution is flatter than a normal distribution.
Which of the above statement(s) is/are correct?
(A) I and IV only
(B) II and III only
(C) I, II, and III only
(D) II, III, and IV only

142. The number of telephone calls received at a call center per minute is often modeled using which probability distribution?
(A) Binomial
(B) Normal
(C) Uniform
(D) Poisson

143. If a dataset has two values that occur with the same highest frequency, the distribution is called:
(A) Bimodal
(B) Unimodal
(C) Multimodal
(D) Non-modal

144. In regression, validation refers to the process of:
(A) Formulating the initial hypothesis about the relationship between variables.
(B) Assessing the performance of a fitted model

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71. An opinion poll asks people to classify their local air quality as Good, Moderate, or Poor. This is an example of measurement on a(n):
(A) Nominal scale
(B) Interval scale
(C) Ratio scale
(D) Ordinal scale

72. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : The log-normal distribution is frequently used for environmental data because concentrations cannot be negative and often have a right-skewed distribution.
Reason (R) : Taking the logarithm of log-normally distributed data tends to produce a normal distribution, which is easier to work with statistically.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

73. What is the fundamental difference between attributes and variables?
(A) Attributes are quantitative, while variables are qualitative.
(B) Attributes relate to samples, while variables relate to populations.
(C) Attributes are qualitative, while variables are quantitative.
(D) There is no difference; the terms are interchangeable.

74. If the probability of a sunny day is 0.7, what is the probability of it not being a sunny day (assuming only two outcomes)?
(A) 0.3
(B) 0.7
(C) 0.5
(D) 1.0

75. Consider the following events in the typical workflow of developing and using a regression model:
I. Forecasting future values.
II. Collecting data for independent and dependent variables.
III. Validating the model with a new dataset.
IV. Fitting the regression model to the collected data (model building).
Which of the following is the correct chronological sequence?
(A) II, IV, III, I
(B) IV, II, III, I
(C) II, III, IV, I
(D) III, II, I, IV

76. In a two-way ANOVA, a significant interaction effect means that:
(A) Both independent variables have a significant effect on the dependent variable.
(B) The effect of one independent variable on the dependent variable depends on the level of the other independent variable.
(C) Neither independent variable has a significant effect on the dependent variable.
(D) The two independent variables are found to be highly correlated with each other.

77. Which of the following statements about the Lotka-Volterra model is incorrect?
(A) It assumes the prey population grows exponentially in the absence of predators.
(B) It assumes the predator population declines exponentially in the absence of prey.
(C) It includes a carrying capacity for the prey population.
(D) It can produce cyclical oscillations in predator and prey populations.

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78. Consider the following statements about statistical concepts:
I. Correlation implies causation.
II. Standard error is a measure of central tendency.
III. The t-distribution is flatter and has heavier tails than the normal distribution.
IV. ANOVA can be used to compare the means of two or more groups.
V. A ratio scale of measurement has a true zero point.
Which of the above statement(s) is/are correct?
(A) I, II, and III
(B) II, III, and IV
(C) III, IV, and V
(D) I, IV, and V

154. If a researcher sets the significance level (α) at 0.01 instead of 0.05, what is the effect on the hypothesis test?
(A) A stronger level of evidence is required to reject the null hypothesis.
(B) The probability of a Type I error increases.
(C) The probability of a Type II error decreases.
(D) The null hypothesis is more likely to be rejected.

155. Which of the following is a non-parametric alternative to the independent samples t-test?
(A) Wilcoxon signed-rank test
(B) Kruskal-Wallis test
(C) Spearman correlation
(D) Mann-Whitney U test

156. Consider the following statements regarding regression models:
I. Linear regression models are always the best fit for environmental data.
II. Multiple regression can assess the impact of several predictors simultaneously.
III. The intercept in a regression model is the predicted value of Y when all predictors are zero.
IV. Validation of a model involves using the same data used for calibration.
V. A good model should have residuals that are randomly scattered around zero.
Which of the above statement(s) is/are correct?
(A) I, II, and IV
(B) II, III, and V
(C) I, III, and IV
(D) II, IV, and V

157. A p-value of 0.85 from a statistical test would lead to which conclusion?
(A) Reject the null hypothesis as the result is highly significant.
(B) Accept the alternative hypothesis with 85% confidence.
(C) Fail to reject the null hypothesis as there is no strong evidence against it
(D) The sample size was too small to draw any conclusion.

158. The standard error of the mean is a measure of:
(A) The degree of variability observed among individual data points within a single sample.
(B) The mathematical skewness found within the specific sample distribution being studied.
(C) The central location of the population data relative to the sample being collected.
(D) The accuracy of the sample mean as an estimate of the population mean.

159. Match the test statistics in List I with the associated distributions in List II.
List I:(Test Statistic)
P. z-score
Q. t-score
R. F-ratio
S. Chi-square statistic
List II:(Associated Distribution)
1. F-distribution
2. Chi-square distribution
3. Standard Normal distribution
4. t-distribution
Choose the correct option from those given below:
(A) P-3, Q-4, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

160. Which of these scenarios is best analyzed using a paired t-test?
(A) Comparing the average height of men and women.
(B) Comparing the blood pressure of a group of patients before and after taking a medication.
(C) Comparing the average income in three different cities.
(D) Examining the relationship between hours of study and exam scores.

161. Consider the following central tendency measures:
I. Mean
II. Median
III. Mode
Which of the following is the correct descending order of their values for a negatively skewed distribution?
(A) I, II, III
(B) III, II, I
(C) II, I, III
(D) III, I, II

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yield (kg/ha)

Q. Difference in crop yield under three different fertilizers

R. Difference in soil pH before and after an acid rain event

S. Association between soil type (categorical) and plant presence/absence

List II:(Appropriate Statistical Test)

1. Paired t-test
2. Simple Linear Regression
3. Chi-square test
4. One-way ANOVA

Choose the correct option from those given below:

(A) P-2, Q-4, R-1, S-3
(B) P-4, Q-2, R-1, S-3
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-2, R-3, S-1

202. A Type II error is committed when a researcher:
(A) Fails to reject a false null hypothesis.
(B) Rejects a true null hypothesis.
(C) Fails to reject a true null hypothesis.
(D) Rejects a false null hypothesis.

203. The distribution of data that is a mirror image on both sides of the center is called:
(A) Skewed
(B) Leptokurtic
(C) Bimodal
(D) Symmetric

204. Consider the following steps for using a Leslie Matrix to project a population:

I. Multiply the Leslie matrix by the initial age distribution vector.

II. Obtain the new age distribution vector for time t+1.

III. Construct the Leslie matrix with fecundity and survival rates.

IV. Determine the initial age distribution vector (n_0).

Which of the following is the correct chronological order?
(A) IV, III, I, II
(B) III, IV, I, II
(C) III, I, IV, II
(D) IV, I, III, II

205. In a simple linear regression equation y = a + bx, the term a represents the:
(A) Slope of the line
(B) Correlation coefficient
(C) y-intercept
(D) Standard error of the estimate

206. Consider the following statements regarding central tendency measures:
Statement I : The mean is always the best measure of central tendency.
Statement II : The median is sensitive to every value in the dataset.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

207. A researcher is studying the number of defects in a batch of 10 manufactured items. If the probability of a single item being defective is 0.1 and defects are independent, which distribution is most appropriate to model the number of defective items in the batch?
(A) Binomial
(B) Poisson
(C) Normal
(D) Log-normal

208. Which of the following is an example of an attribute?
(A) The weight of a fish.
(B) The color of a flower.
(C) The length of a river.
(D) The concentration of a chemical.

209. The purpose of a t-test is to:
(A) Assess the significance of differences between means among three or more groups.
(B) Assess the significance of the difference between the means of two groups.
(C) Assess the association between two categorical variables in a contingency table.
(D) Assess the fit of observed data to a specific theoretical probability distribution.

172. Consider the following statements regarding sampling:
Statement I : A simple random sample is always representative of the population.
Statement II : Sampling error is the difference between a sample statistic and the true population parameter.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

173. The F-test in the context of multiple regression is used to assess:
(A) The significance of each individual independent variable.
(B) Whether the residuals are normally distributed.
(C) The overall significance of the entire regression model
(D) The presence of multicollinearity among independent variables.

174. Which of these is a continuous variable?
(A) Number of leaves on a tree.
(B) Number of cars in a parking lot.
(C) Number of eggs in a nest.
(D) Weight of a soil sample.

175. The sum of the probabilities of all possible outcomes of a random experiment is always:
(A) 1
(B) 0
(C) Dependent on the number of outcomes
(D) 0.5

176. What is the effect of increasing the confidence level (e.g., from 95% to 99%) on the width of a confidence interval?
(A) The interval becomes narrower.
(B) The interval becomes wider.
(C) The width of the interval remains unchanged.
(D) The effect depends on the sample size.

177. Which of the following is NOT an approach to the development of environmental models?
(A) Using linear regression to establish relationships.
(B) Using purely anecdotal evidence without any data
(C) Using process-based differential equations like Lotka-Volterra.
(D) Using matrix models like Leslie's to project population changes.

178. A value of Kurtosis significantly greater than 3 (or positive excess kurtosis) indicates a distribution that is:
(A) Leptokurtic (peaked with heavy tails)
(B) Platykurtic (flat with light tails)
(C) Mesokurtic (normal)
(D) Bimodal (two peaks)

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179. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : ANOVA is an extension of the t-test.
Reason (R) : While a t-test compares the means of two groups, ANOVA can compare the means of two or more groups, and a two-group ANOVA is mathematically equivalent to a t-test.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

180. The primary purpose of simple linear regression is to:
(A) Compare the means of two groups.
(B) Test for association between two categorical variables.
(C) Compare the variances of two groups.
(D) Model the linear relationship between two continuous variables.

181. Match the statistical concepts in List I with their descriptions in List II.
List I:(Statistical Concept)
P. Skewness
Q. Kurtosis
R. Standard Error
S. Variance

Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

221. Match the statistical measures in List I with their purposes in List II.
List I:(Measure)
P. Mean
Q. Standard Deviation
R. Coefficient of Variation
S. Skewness
List II:(Purpose)
1. Measure of relative dispersion
2. Measure of central location
3. Measure of asymmetry
4. Measure of absolute dispersion
Choose the correct option from those given below:
(A) P-2, Q-4, R-3, S-1
(B) P-2, Q-4, R-1, S-3
(C) P-4, Q-2, R-1, S-3
(D) P-4, Q-2, R-3, S-1

222. The term forecasting in the context of environmental modeling refers to:
(A) Using a model to estimate parameters.
(B) Using a model to understand past events.
(C) Comparing a model's output to observed data.
(D) Using a model to predict future states or values.

223. What does it mean if two variables have a correlation coefficient of r = -1?
(A) There is a perfect negative linear relationship between the variables.
(B) There is no relationship between the variables.
(C) As one variable increases, the other variable also increases perfectly.
(D) The variables are independent.

224. Which of the following is NOT an assumption of simple linear regression?
(A) A linear relationship between the independent and dependent variables.
(B) The independent variable must be normally distributed.
(C) The residuals are normally distributed.
(D) Homoscedasticity (constant variance of residuals).

225. A key difference between one-way and two-way ANOVA is that two-way ANOVA:
(A) Can only be used with two groups.
(B) Can analyze the effect of two independent variables simultaneously.
(C) Does not require the assumption of normality.
(D) Is a non-parametric test.

226. Consider the following statements about probability distributions:
I. The Normal distribution is symmetric.
II. The Poisson distribution is used for count data.
III. The Binomial distribution models the number of successes in a fixed number of trials.
IV. The t-distribution is used when the population variance is known.
Which of the above statement(s) is/are correct?
(A) I, II, and IV only
(B) I, III, and IV only
(C) II, III, and IV only
(D) I, II, and III only

227. The first step in developing an environmental model is typically:
(A) Validation
(B) Forecasting
(C) Defining the model's objectives and scope.
(D) Data collection.

228. The variance of a sample is:
(A) The calculated average of distance of data points from the population mean.
(B) The square root of the standard deviation, representing the data spread.
(C) Always smaller than the population variance due to the degrees of freedom.
(D) A measure of the average of the squared deviations from the sample mean.

229. If a researcher fails to reject the null hypothesis, it means that:

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(A) Lotka-Volterra competition model
(B) Simple linear regression model
(C) Logistic growth model
(D) Leslie's matrix model

191. Which of the following is not a measure of central tendency?
(A) Standard Deviation
(B) Mean
(C) Median
(D) Mode

192. A parameter is a numerical characteristic of a:
(A) Sample
(B) Population
(C) Variable
(D) Model

193. The probability of an event that is certain to happen is:
(A) 0
(B) 1
(C) 0.5
(D) undefined

194. If the p-value for an F-test in ANOVA is 0.001, it suggests that:
(A) There is a highly significant difference between at least two of the group means
(B) There is no significant difference between the group means.
(C) The variances of the groups are not equal.
(D) All group means are different from each other.

195. Consider the following statements about measures of shape:
I. Skewness describes the symmetry of a distribution.
II. Kurtosis describes the peakedness of a distribution.
III. A normal distribution has a skewness of 0.
IV. A normal distribution has a kurtosis of 1.
Which of the above statement(s) is/are correct?
(A) I and II only
(B) I, II, and III only
(C) II, III, and IV only
(D) I, III, and IV only

196. A statistic is a numerical characteristic of a:
(A) Population
(B) Parameter
(C) Hypothesis
(D) Sample

197. Which of the following is an example of a ratio scale measurement?
(A) Body temperature in Celsius.
(B) Calendar year (e.g., 2023).
(C) Height of a person in centimeters.
(D) A person's nationality.

198. The main advantage of stratified random sampling over simple random sampling is that it:
(A) Is easier and cheaper to implement.
(B) Can ensure representation from different subgroups of the population.
(C) Requires a smaller sample size.
(D) Eliminates all sampling error.

199. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : The Lotka-Volterra models are deterministic.
Reason (R) : Given the same initial conditions and parameters, the models will always produce the exact same population trajectories, without accounting for random environmental fluctuations or chance events.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

200. What is the relationship between variance and standard deviation?
(A) Standard deviation is the square root of the variance.
(B) Standard deviation is the square of the variance.
(C) Variance is the square root of the standard deviation.
(D) They are unrelated measures of dispersion.

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201. Match the study designs in List I with the appropriate statistical tests in List II.
List I:(Study Design)
P. Relationship between rainfall (cm) and crop

239. Which of the following represents a key difference between interval and ratio scales?
(A) Ratio scales have a true zero point, while interval scales do not.
(B) Interval scales have a true zero point, while ratio scales do not.
(C) Interval scales can be ranked, but ratio scales cannot.
(D) Ratio scales are for categorical data, while interval scales are for continuous data.

240. The symbol 'χ^2' refers to which statistical concept?
(A) The t-test
(B) The Chi-square test
(C) The F-test
(D) The Pearson correlation

241. Consider the following statements about hypothesis tests:
I. A t-test compares the means of two groups.
II. A χ^2-test is used for categorical data.
III. A one-way ANOVA compares the means of three or more groups.
IV. A two-way ANOVA examines the effects of one independent variable.
V. A paired t-test is used for independent samples.
Which of the above statement(s) is/are correct?
(A) I, II, and V
(B) II, III, and IV
(C) I, II, and III
(D) I, IV, and V

242. In the expression for a normal distribution, the parameters that define the specific shape and location of the curve are:
(A) Mean (μ) and standard deviation (σ)
(B) Skewness and Kurtosis
(C) Sample size and degrees of freedom
(D) Alpha (α) and Beta (β)

243. The primary limitation of the basic Lotka-Volterra models is that they are:
(A) Too complex to be solved analytically.
(B) Only applicable to plant populations.
(C) Deterministic and do not include environmental stochasticity or carrying capacity for prey.
(D) Unable to produce cyclical dynamics.

244. If the correlation between two variables is 0, the R^2 value will be:
(A) 1
(B) 0.5
(C) -1
(D) 0

245. Match the items in List I with their primary purposes in List II based on statistical models.
List I:(Model)
P. Lotka-Volterra Model
Q. Leslie's Matrix Model
R. Simple Regression Model
S. Multiple Regression Model
List II:(Primary Purpose)
1. Projecting age-structured population growth
2. Predicting a continuous variable from one or more predictors
3. Describing predator-prey or competitive interactions
4. Predicting a continuous variable from a single predictor
Choose the correct option from those given below:
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-4, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-1, R-3, S-4

246. The standard deviation is a measure of:
(A) How much the sample mean is likely to differ from the population mean.
(B) The typical or average distance of data points from their mean.
(C) The asymmetry of a distribution.
(D) The most frequent value in a dataset.

247. A linear model is one in which:
(A) The relationship between variables forms a curve.
(B) The data set must be perfectly linear for the model to function.
(C) The statistical model can only contain two specific variables.
(D) The parameters to be estimated appear linearly in the equation.

248. The value of the F-statistic in an ANOVA is always:
(A) Non-negative (≥ 0)

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210. Consider the following statements about correlation and regression:
I. Correlation measures the strength and direction of a linear relationship.
II. Regression provides an equation to model the relationship.
III. The square of the Pearson correlation coefficient is the coefficient of determination (R^2).
IV. A regression model can be built even if the correlation is zero.
V. A negative correlation means the variables are not related.
Which of the above statement(s) is/are correct?
(A) I, II, III, and IV
(B) II, III, IV, and V
(C) I, II, IV, and V
(D) I, III, and V

211. The term ANOVA stands for:
(A) Analysis of Normality and Variance
(B) Association of Variance
(C) Analysis of Variance
(D) And-Or Variance Assessment

212. Which of the following is a key feature of the Lotka-Volterra predator-prey model?
(A) Linear population growth.
(B) Age-structured populations.
(C) A fixed carrying capacity for predators.
(D) Oscillatory dynamics of predator and prey populations.

213. The standard normal distribution is a special case of the normal distribution where:
(A) the mean is 1 and the standard deviation is 0
(B) the mean is equal to the variance
(C) the mean is 0 and the standard deviation is 1
(D) the distribution is discrete

214. If a regression model is statistically significant, it means that:
(A) The model perfectly predicts the dependent variable.
(B) The relationship observed in the sample is likely to exist in the population.
(C) The independent variable causes the dependent variable.
(D) The model is valid for forecasting in all situations.

215. What is measured on a nominal scale?
(A) Wind speed
(B) Earthquake intensity on the Richter scale
(C) Geographic coordinates (latitude/longitude)
(D) The country of origin for an imported product

216. In hypothesis testing, which of the following is true?
(A) The significance level α is the probability of a Type I error.
(B) Decreasing the risk of a Type I error also decreases the risk of a Type II error.
(C) The sum of the probabilities of Type I and Type II errors is always 1.
(D) The power of a test is the probability of a Type I error.

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217. In a Leslie Matrix L, the entry L(1,j) represents:
(A) The probability of survival of an individual of age class j.
(B) The number of individuals in age class j.
(C) The number of offspring produced by an individual of age class j
(D) The probability of an individual of age class j dying.

218. The mean of a Poisson distribution with parameter λ is:
(A) λ
(B) λ^2
(C) $1/\lambda$
(D) $\sqrt{\lambda}$

219. A study examines the concentration of a pesticide in river water samples taken in four different seasons. To test if the mean concentration differs significantly between seasons, the appropriate method is:
(A) Simple linear regression
(B) Two-way ANOVA
(C) Paired t-test
(D) One-way ANOVA

220. Consider the following statements regarding regression analysis:
Statement I : A regression line is the line that best fits the data points in a scatter plot.
Statement II : The best fit is typically determined by maximizing the sum of squared residuals.

162. The following question consists of two statements, an Assertion (A) and a Reason (R).
Assertion (A) : Correlation does not imply causation.
Reason (R) : A strong correlation between two variables may be due to a third, unobserved confounding variable.
Choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

163. The primary data input for a Leslie matrix model is:
(A) Predator and prey population sizes.
(B) Environmental carrying capacity.
(C) Age-specific survival and fecundity rates.
(D) Resource competition coefficients.

164. In a normal distribution, what percentage of observations lies within ±2 standard deviations of the mean?
(A) Approximately 68%
(B) Approximately 99.7%
(C) 100%
(D) Approximately 95%.

165. The term moment in statistics refers to a quantitative measure related to the shape of a distribution. The first moment about the origin is the:
(A) Variance
(B) Skewness
(C) Mean
(D) Kurtosis

166. A researcher wants to see if there is a difference in the proportion of male and female students who pass an environmental science exam. Which test is most appropriate?
(A) t-test
(B) Chi-square test for independence
(C) ANOVA
(D) Linear regression

167. Which of the following is a key goal of model validation?
(A) To ensure the model is as complex as possible.
(B) To find the set of parameters that best fit the training data.
(C) To prove that the model's underlying theory is correct.
(D) To confirm that the model's predictions are accurate for data it has not seen before.

168. Consider the following statements regarding statistical tests:
I. A t-test is used to compare the means of two groups.
II. ANOVA is used to compare the variances of two or more groups.
III. A Chi-square test is primarily used for continuous data.
IV. Regression analysis models the relationship between dependent and independent variables.
Which of the above statement(s) is/are correct?
(A) I and IV only
(B) I and II only
(C) II and III only
(D) III and IV only

169. What type of model is the Lotka-Volterra predator-prey system?
(A) A set of linear algebraic equations.
(B) A single-variable logistic growth equation.
(C) A set of coupled non-linear differential equations
(D) A matrix-based population projection model.

170. If a distribution is symmetric, its skewness coefficient will be:
(A) 0
(B) 1
(C) -1
(D) 3

171. The degrees of freedom for a statistical test are related to:
(A) The number of variables in the study.
(B) The significance level chosen for the test.
(C) The power of the test.
(D) The number of independent pieces of information available to estimate a parameter.

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(A) The null hypothesis is proven to be true with high statistical certainty.
(B) The alternative hypothesis is proven to be false by the experimental data.
(C) There is not enough statistical evidence to conclude the alternative hypothesis is true.
(D) A Type I error has definitely been committed during the statistical analysis.

230. A Chi-square goodness-of-fit test is appropriate for:
(A) Testing the difference between two sample means.
(B) Testing if sample data comes from a population with a specific distribution.
(C) Modeling the linear relationship between two variables.
(D) Comparing the variances of three or more groups.

231. Consider the following model types:
I. Multiple Regression
II. Simple Linear Regression
III. One-way ANOVA model
Which of the following is the correct sequence from simplest to most complex based on the typical number of variables they handle?
(A) II, III, I
(B) III, II, I
(C) I, II, III
(D) II, I, III

232. In the Lotka-Volterra predator-prey equations, the prey population growth is limited by:
(A) Predation
(B) Carrying capacity
(C) Both carrying capacity and predation
(D) The growth rate of the predator population

233. The value in a dataset that occurs more often than any other is the:
(A) Mean
(B) Median
(C) Mode
(D) Range

234. Consider the following statements regarding measures of dispersion:
Statement I : The standard deviation can be a negative number.
Statement II : The variance is measured in the same units as the original data.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

235. Which of the following correctly describes a population in a statistical context?
(A) A subset of individuals selected for a study.
(B) A numerical summary of a sample.
(C) The process of collecting data.
(D) The entire group of individuals or objects that a researcher is interested in.

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236. A multiple regression model is more appropriate than a simple linear regression model when:
(A) The relationship between the variables is non-linear.
(B) The dependent variable is influenced by more than one independent variable.
(C) The data is categorical.
(D) The sample size is very small.

237. The Central Limit Theorem is fundamental to hypothesis testing because it states that, for a large sample size, the sampling distribution of the mean will be:
(A) Identical to the population distribution.
(B) A t-distribution with n-1 degrees of freedom.
(C) Approximately normal, regardless of the population's distribution.
(D) Positively skewed.

238. In a two-way ANOVA, if the interaction effect is significant, what is the best next step?
(A) Ignore the interaction and only report the main effects.
(B) Conclude that both factors are independently important.
(C) Re-run the analysis as two separate one-way ANOVAs.
(D) Examine the simple main effects (the effect of one factor at each level of the other factor).

List II:(Brief Description)
1. Measure of peakedness of a distribution
2. Measure of asymmetry of a distribution
3. Standard deviation of a sampling distribution
4. Average of squared deviations from the mean

Choose the correct option from those given below:
(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-4, S-3

182. Which of the following statements about the χ^2 (Chi-square) distribution is correct?
(A) It is always a symmetric distribution.
(B) Its shape is determined by a single parameter, the degrees of freedom
(C) It can take on negative values.
(D) It is used to compare the means of two groups.

183. The rank of a student in a class (1st, 2nd, 3rd, etc.) represents what scale of measurement?
(A) Nominal
(B) Interval
(C) Ratio
(D) Ordinal

184. Consider the following statements regarding the Lotka-Volterra models:
I. The competition model can predict coexistence or competitive exclusion.
II. The predator-prey model assumes predators have unlimited appetite.
III. The predator-prey model includes a carrying capacity for the predator.
IV. Both models are expressed as pairs of differential equations.
V. The models are inherently stochastic, including random chance.

Which of the above statement(s) is/are correct?
(A) I, II, and IV
(B) II, III, and V
(C) I, III, and IV
(D) I, IV, and V

185. A researcher calculates a correlation coefficient between variable A and variable B as $r = 1.25$. What can be concluded?
(A) There is a very strong positive linear relationship.
(B) There is a strong non-linear relationship.
(C) There is a calculation error, as the correlation coefficient cannot be greater than 1
(D) Variable A causes variable B.

186. Which of the following is a key assumption for conducting a one-way ANOVA?
(A) The data within each group are approximately normally distributed.
(B) The samples are dependent.
(C) The variances within each group are unequal (heteroscedasticity).
(D) The dependent variable is measured on a nominal scale.

187. The total number of observations in a dataset is referred to as the:
(A) Frequency
(B) Standard deviation
(C) Range
(D) Sample size

188. Consider the following statements regarding probability distributions:
Statement I : The Binomial distribution is a continuous probability distribution.
Statement II : The Normal distribution is a discrete probability distribution.
Which of the following is correct?
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

189. In a multiple regression model, $Y = b_0 + b_1X_1 + b_2X_2$, the coefficient b_1 represents:
(A) The total change in Y for a one-unit change in X_1.
(B) The simple correlation between Y and X_1.
(C) The change in Y for a one-unit change in X_1, holding X_2 constant.
(D) The proportion of variance explained by X_1.

190. Which of these statistical models explicitly incorporates the age structure of a population?

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(B) Between 0 and 1
(C) Negative
(D) Equal to the t-statistic squared

249. A researcher measures the wingspan of birds in a sample. This variable is:
(A) An attribute
(B) A discrete variable
(C) A continuous variable
(D) A nominal variable

250. Which of the following is a correct statement regarding model validation?
(A) It assesses how well the model generalizes to new, independent data.
(B) It should be performed using the same data that was used to build the model.
(C) It is an optional step that is often skipped in environmental science.
(D) Its sole purpose is to increase the R^2 value of the model.

Direction : Please read the following source carefully.

In environmental sciences, the systematic study of phenomena begins with the clear distinction between attributes and variables. An attribute refers to a qualitative characteristic that cannot be numerically measured but can be categorized, such as the species of a tree or the texture of soil. In contrast, a variable is a characteristic that can be measured and assumes different numerical values. Variables are further classified based on the nature of their values and the scale of measurement. The scale of measurement dictates the mathematical operations that can be performed on the data. The nominal scale is the most basic, involving the classification of data into distinct, unordered categories (e.g., land use types like 'forest', 'urban', 'agricultural'). The ordinal scale introduces a rank or order among categories, but the intervals between ranks are not necessarily equal (e.g., water quality ranked as 'good', 'fair', 'poor'). The interval scale provides ordered data with equal intervals between values, but it lacks a true, meaningful zero point (e.g., temperature in Celsius, where 0°C does not signify the absence of heat). Finally, the ratio scale represents the highest level of measurement, possessing all the properties of the interval scale plus a true zero point, allowing for the calculation of ratios (e.g., concentration of a pollutant in mg/L, where 0 mg/L means the complete absence of the pollutant).

Based on the above source, attempt the following five questions.

251. Which of the following environmental measurements represents data on an interval scale?
(A) Annual rainfall in millimeters
(B) Temperature in degrees Celsius
(C) Soil pH level
(D) The number of endangered birds in a sanctuary

252. A researcher classifies water bodies in a region as 'river', 'lake', 'pond', and 'wetland'. What scale of measurement is being used?
(A) Nominal
(B) Ordinal
(C) Interval
(D) Ratio

253. According to the passage, what is the fundamental difference between an attribute and a variable?
(A) An attribute is always discrete, while a variable is always continuous.
(B) An attribute is used for populations, while a variable is used for samples.
(C) An attribute is a qualitative characteristic, whereas a variable is a measurable quantity.
(D) An attribute has a true zero, whereas a variable does not.

254. A study ranks the severity of soil erosion as 'low', 'moderate', and 'high'. Why is this considered an ordinal scale of measurement?
(A) It has a true zero point indicating no erosion.
(B) The difference between 'low' and 'moderate' is numerically equal to the difference between 'moderate' and 'high'.
(C) The categories are mutually exclusive and have no intrinsic order.
(D) The categories have a clear order, but the magnitude of difference between them is not defined.

255. The ability to state that a pollutant concentration of 20 mg/L is twice as high as 10 mg/L is a characteristic of which scale of measurement?

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environmental systems. These models can range from simple conceptual diagrams to sophisticated mathematical formulations. A prominent category within this field is based on linear statistical relationships, particularly simple and multiple regression models. These models are pragmatic tools for quantifying the influence of various factors on an environmental outcome. A simple linear regression model establishes a relationship between a single predictor (independent) variable and a response (dependent) variable, assuming a straight-line relationship. For instance, it could model the effect of fertilizer application rate on crop yield. When an environmental phenomenon is influenced by several factors simultaneously, a multiple regression model is employed. This extends the simple model by incorporating two or more predictor variables. A crucial part of the modeling process extends beyond its creation. Model validation is the essential step of assessing the model's performance and accuracy by testing it against a new, independent dataset that was not used in its development. Only after a model has been validated can it be confidently used for forecasting, which involves using the model to predict future environmental states, outcomes, or impacts under different scenarios, thereby serving as a vital tool for policy-making and environmental management.

Based on the above source, attempt the following five questions.

291. What is the principal purpose of model validation in the environmental modeling process?
(A) To develop the initial mathematical formula for the model.
(B) To select the independent variables to be included in the model.
(C) To assess the model's accuracy using an independent dataset.
(D) To use the model for predicting future environmental states.

292. How does a multiple regression model differ from a simple linear regression model?
(A) It incorporates two or more predictor variables to explain a response.
(B) It assumes a non-linear relationship between variables.
(C) It involves only one predictor variable.
(D) It is used exclusively for conceptual diagrams, not mathematical formulations.

293. Using a validated environmental model to predict the rise in sea level for the year 2050 based on projected CO_2 emissions is an example of:
(A) Model development
(B) Model validation
(C) Simple regression
(D) Forecasting

294. Which of the following scenarios would be best represented by a simple linear regression model?
(A) Predicting air quality based on traffic volume, industrial output, and weather conditions.
(B) Modeling the relationship between water temperature and the dissolved oxygen level in a lake.
(C) Simulating predator-prey population dynamics over time.
(D) Assessing the association between land use type and bird species diversity.

295. According to the passage, what is a primary goal of developing environmental models?
(A) To replace the need for real-world data collection.
(B) To create complex systems that are difficult to understand.
(C) To simulate and predict the behavior of environmental systems.
(D) To prove that all environmental relationships are linear.

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Direction : Please read the following source carefully.

Ecological modeling provides quantitative tools to understand population dynamics and species interactions. Two classic and foundational models are the Lotka-Volterra model and Leslie's matrix model. The Lotka-Volterra model is a set of coupled, first-order, nonlinear differential equations that describe the dynamics of two interacting species, classically a predator and its prey. The model illustrates how the populations of the predator and prey species fluctuate in a cyclical pattern over time; the prey population's growth is limited by predation, and the predator population's growth is limited by the availability of prey. Despite its simplifying assumptions, it

characterize a distribution. The first moment about the origin is the mean, providing a measure of location. The second central moment (the moment about the mean) is the variance, which quantifies dispersion. Higher-order moments provide more nuanced information about the distribution's shape. Specifically, the third central moment is used to measure skewness, which indicates the asymmetry of the distribution. A distribution with a longer tail extending to the right is said to be positively skewed, where the mean is typically greater than the median. Conversely, a distribution with a longer tail to the left is negatively skewed. A value of zero indicates a perfectly symmetric distribution. The fourth central moment is used to calculate kurtosis, a measure of the tailedness or peakedness of a distribution compared to a normal distribution. A distribution that is more peaked and has heavier tails than a normal distribution is described as leptokurtic. A distribution that is flatter and has lighter tails is termed platykurtic. A distribution with the same kurtosis as a normal distribution is mesokurtic. These measures are crucial for determining if a dataset conforms to the assumptions of certain statistical tests.

Based on the above source, attempt the following five questions.

261. What aspect of a data distribution is measured by the third central moment?
(A) Central location
(B) Dispersion
(C) Peakedness
(D) Asymmetry

262. A dataset of annual fish catch sizes reveals a distribution where the mean is significantly smaller than the median. This distribution can be described as:
(A) Positively skewed
(B) Negatively skewed
(C) Leptokurtic
(D) Platykurtic

263. Kurtosis is a statistical measure used to describe which characteristic of a probability distribution?
(A) The degree of its linear relationship with another variable
(B) The number of peaks in the distribution
(C) The tailedness and peakedness relative to a normal distribution
(D) The spread of the data relative to the mean

264. A researcher finds that the distribution of a certain soil nutrient is flatter and has lighter tails than a normal distribution. How would this distribution be classified in terms of kurtosis?
(A) Mesokurtic
(B) Leptokurtic
(C) Negatively skewed
(D) Platykurtic

265. According to the passage, the variance of a dataset corresponds to which statistical moment?
(A) The second central moment
(B) The first moment about the origin
(C) The third central moment
(D) The fourth central moment

Direction : Please read the following source carefully.

The foundation of inferential statistics, which allows environmental scientists to draw conclusions about a population from a sample, rests upon the basic concepts of probability theory and sampling theory. Probability theory provides the mathematical framework for quantifying uncertainty, defining the likelihood of an event's occurrence on a scale from 0 (impossibility) to 1 (certainty). This theory is essential for understanding the random variation inherent in environmental data and for constructing statistical tests. Building on this, sampling theory addresses the methods and principles for selecting a subset of individuals from a larger population to estimate the characteristics of the whole population. The primary objective is to obtain a representative sample, meaning the sample's characteristics accurately reflect the population's characteristics. A failure to do so results in a biased sample, leading to invalid inferences. The process involves defining a sampling frame, which is a list or map of all items from which a sample is drawn. An inherent challenge in sampling is sampling error, which is the discrepancy between a sample statistic (e.g., sample mean) and the corresponding population parameter it is estimating. While sampling error cannot be entirely eliminated, appropriate sampling

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ANSWERS

1. (B) an attribute
Qualitative data represents characteristics that cannot be measured using numerical values but are instead categorized based on specific traits or qualities. In statistical terminology, these non-numeric characteristics are defined as attributes. Examples include gender, color, or religious affiliation. Unlike quantitative variables, attributes do not possess numerical magnitude, though they can be coded numerically for analysis. They are essential for classifying data into distinct, non-overlapping groups.

2. (A) Interval
The interval scale of measurement identifies both the order of values and the exact differences between them. Temperature measured in Celsius or Fahrenheit is a classic example because the difference between degrees is consistent. However, this scale lacks a true zero point, meaning zero degrees does not signify the complete absence of heat. Consequently, mathematical ratios cannot be calculated, though addition and subtraction remain valid.

3. (C) I, II, and IV only
The arithmetic mean is a fundamental measure of central location calculated by summing all observations and dividing by the total count. It possesses several key properties, including a significant sensitivity to extreme outliers. Additionally, the sum of deviations of individual data points from the mean always equates to zero. However, it cannot be used for nominal data, as qualitative categories lack the numerical basis required for calculation.

4. (C) Statement I is correct but Statement II is incorrect.
The median is correctly defined as the middle value in an ordered dataset, effectively splitting the distribution into two equal parts. While the mode represents the most frequent value, it is not always the most suitable measure for bimodal distributions. In cases with two peaks, reporting both modes or using alternative measures often provides better insight into the data structure than selecting a single, potentially misleading central value.

NODIA

5. (C) Mode
The mode is a measure of central tendency that identifies the most frequently occurring value within a specific dataset. It is particularly useful for nominal data where numerical calculations like the mean are impossible. A distribution may have one mode, multiple modes, or no mode at all if all values occur with equal frequency. This measure highlights the most common characteristic or popular category in a population.

6. (A) Both A and R are true and R is the correct explanation of A.
Standard deviation is the square root of variance and serves as a measure of data dispersion. Since variance is calculated by averaging squared deviations from the mean, it is inherently non-negative. Taking the square root of a non-negative value ensures that the standard deviation remains zero or positive. This statistical property makes it a reliable indicator of the spread of values around the arithmetic mean.

7. (D) The mean is greater than the median, and the tail extends to the right.
In a positively skewed distribution, the majority of data points are concentrated on the left side, while a few extreme high values pull the tail toward the right. This asymmetry causes the arithmetic mean to be shifted further toward the tail than the median and mode. Consequently, the mean is typically the largest value, reflecting the influence of outliers that are much greater than most.

8. (A) Median
When a dataset contains extreme outliers or is highly skewed, the arithmetic mean can be significantly distorted and may not represent the typical value. In such instances, the median is the preferred measure of central tendency because it is robust against extreme values. By representing the middle point of an ordered set, the median

(C) Because pollutant concentrations are often symmetric and bell-shaped.
(D) Because the logarithm of a normal distribution is always positive.

273. A quality control test involves checking 20 water samples for the presence or absence of a specific contaminant. Which distribution would model the number of contaminated samples found?
(A) Poisson distribution
(B) Normal distribution
(C) Log-normal distribution
(D) Binomial distribution

274. What is a defining characteristic of a variable that follows a log-normal distribution?
(A) The logarithm of the variable is normally distributed.
(B) The variable itself is normally distributed.
(C) The variable can only take on integer values.
(D) The variable's distribution is perfectly symmetrical.

275. The symmetric, bell-shaped distribution that is fundamental to many parametric statistical tests is known as the:
(A) Poisson distribution
(B) Binomial distribution
(C) Normal distribution
(D) Log-normal distribution

Direction : Please read the following source carefully.

Beyond the common descriptive distributions, statistical inference and hypothesis testing rely on a specific set of sampling distributions. These include the t, Chi-square (χ^2), and F-distributions. The t-distribution is central to situations where inferences about a population mean are made using a small sample size (typically $n < 30$) and when the population variance is unknown. Its shape is similar to the normal distribution—symmetric and bell-shaped—but with heavier tails, which accounts for the increased uncertainty associated with small samples. As the sample size increases, the t-distribution converges to the normal distribution. The Chi-square (χ^2) distribution is derived from the sum of squared standard normal deviates. It is a positively skewed distribution and is fundamental for a variety of tests. The χ^2-test for goodness of fit assesses whether an observed frequency distribution matches a theoretical one, while the χ^2-test for independence determines if there is a significant association between two categorical variables. The F-distribution, also known as the variance ratio distribution, is used to compare the variances of two or more independent populations. It is the theoretical basis for Analysis of Variance (ANOVA), a powerful technique for comparing the means of three or more groups by analyzing their variances. The F-distribution is a positively skewed distribution defined by two separate degrees of freedom.

Based on the above source, attempt the following five questions.

276. In which of the following scenarios is the use of the t-distribution most appropriate for hypothesis testing?
(A) Comparing the mean of a small sample to a known value when the population variance is unknown.
(B) Comparing the means of two groups with a large sample size and known population variance.
(C) Testing the association between two categorical variables, such as soil type and plant species.
(D) Comparing the variances of three different populations of fish length.

277. A researcher wants to determine if the observed frequency of different tree species in a forest plot significantly differs from the expected frequencies based on a regional survey. Which statistical test, based on its underlying distribution, should be used?
(A) t-test
(B) ANOVA
(C) Chi-square (χ^2) test for independence
(D) Chi-square (χ^2) test for goodness of fit

278. The F-distribution is the theoretical foundation for which statistical procedure?
(A) Calculating correlation coefficients
(B) Analysis of Variance (ANOVA)
(C) Estimating the median of a population
(D) Performing a t-test with small samples

279. What is a key characteristic of the t-distribution compared to the normal distribution?

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techniques aim to minimize it and allow for its quantification, thereby ensuring the reliability of the conclusions drawn.

Based on the above source, attempt the following five questions.

266. What is the principal objective of sampling theory in environmental science?
(A) To analyze every individual in a population
(B) To obtain a representative subset of a population for making valid inferences
(C) To eliminate all errors in data collection
(D) To prove that a specific event is an absolute certainty

267. Within the context of statistical inference, what role does basic probability theory play?
(A) It provides a method for selecting a sample from a population.
(B) It offers a framework for quantifying the uncertainty associated with events.
(C) It ensures that the sampling error is always zero.
(D) It defines the physical attributes of a population.

268. What is the most likely consequence of using a non-representative sample in a study?
(A) The conclusions drawn about the population will be invalid.
(B) The sampling error will be reduced to zero.
(C) The sample size will be identical to the population size.
(D) The probability of all events will become 1.

269. The discrepancy between a statistic calculated from a sample and the true parameter of the population is known as:
(A) A sampling frame
(B) A representative sample
(C) Sampling error
(D) Probability theory

270. What is a sampling frame as described in the passage?
(A) The statistical summary of the sample data
(B) The final report of the environmental study
(C) The theoretical model of the population
(D) A list or map of all items from which a sample is selected

Direction : Please read the following source carefully.

In statistical analysis of environmental data, various probability distributions are used to model the behavior of different types of variables. The choice of distribution is critical as it forms the basis for hypothesis testing and parameter estimation. For discrete variables, the Binomial and Poisson distributions are common. The Binomial distribution models the number of 'successes' in a fixed number of independent trials, each with the same probability of success (e.g., the number of viable seeds out of ten planted). The Poisson distribution is used to model the number of times an event occurs within a specified interval of time or space, and it is particularly useful for rare events (e.g., the number of mutations in a DNA sequence per year). For continuous variables, the Normal distribution is paramount. It is a symmetric, bell-shaped distribution defined by its mean and standard deviation, and it underpins many parametric statistical tests. However, much environmental data, such as pollutant concentrations or species abundance, are inherently non-negative and often skewed. In such cases, the log-normal distribution is frequently more appropriate. A variable is log-normally distributed if the natural logarithm of the variable is normally distributed. This distribution is defined for positive values only and is right-skewed, making it suitable for modeling variables that span several orders of magnitude.

Based on the above source, attempt the following five questions.

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271. A researcher is studying the number of a rare plant species found per square kilometer in a large national park. Which probability distribution would be most appropriate for modeling this count data?
(A) Normal distribution
(B) Binomial distribution
(C) Poisson distribution
(D) Log-normal distribution

272. Why is the log-normal distribution often a better fit for environmental data like pollutant concentrations than the normal distribution?
(A) Because pollutant concentrations are discrete variables.
(B) Because pollutant data are often right-skewed and cannot be negative.

285. What is the primary output of a regression analysis that distinguishes it from a correlation analysis?
(A) A p-value
(B) A correlation coefficient (r)
(C) An equation that models the relationship between variables
(D) A descriptive statistic like the mean

Direction : Please read the following source carefully.

The process of hypothesis testing is a cornerstone of the scientific method in environmental sciences, providing a formal procedure for making decisions about population parameters based on sample data. The framework begins with the formulation of two competing hypotheses: the null hypothesis (H_0) and the alternative hypothesis (H_1). The null hypothesis typically represents a statement of no effect or no difference, which the researcher aims to challenge. The alternative hypothesis represents the claim or theory that the researcher believes to be true. To test the null hypothesis, a relevant test statistic is calculated from the sample data. Common statistical tests include the t-test, used for comparing the means of two groups, and the χ^2-test, employed for analyzing categorical data. The calculated test statistic is then used to determine a p-value, which is the probability of observing a result as extreme as, or more extreme than, the one obtained, assuming the null hypothesis is true. This p-value is compared against a pre-determined significance level (alpha, α), commonly set at 0.05. If the p-value is less than α, the null hypothesis is rejected. Complementary to hypothesis testing, confidence limits define a range of values, known as a confidence interval, within which the true population parameter is likely to lie with a certain degree of confidence (e.g., 95%).

Based on the above source, attempt the following five questions.

286. In the context of hypothesis testing, what is the function of the null hypothesis (H_0)?
(A) It is the hypothesis that the researcher is trying to prove.
(B) It represents the range of plausible values for a population parameter.
(C) It is the probability of observing a result if the alternative hypothesis is true.
(D) It is a statement of no effect or no difference that is tested against.

287. A researcher conducts a study and reports a p-value of 0.03. With a pre-determined significance level (α) of 0.05, what is the appropriate conclusion?
(A) The null hypothesis should not be rejected.
(B) The alternative hypothesis is false.
(C) The null hypothesis should be rejected.
(D) The study design was flawed.

288. A 95% confidence interval for the mean concentration of a pesticide is calculated to be [10.2 ppm, 11.8 ppm]. What is the correct interpretation of this interval?
(A) There is a 95% probability that the sample mean falls between 10.2 and 11.8 ppm.
(B) We are 95% confident that the true population mean concentration lies between 10.2 and 11.8 ppm.
(C) 95% of the data points in the sample fall between 10.2 and 11.8 ppm.
(D) The probability of the null hypothesis being true is 5%.

289. According to the passage, when is a t-test an appropriate statistical procedure?
(A) When testing for an association between two categorical variables.
(B) When comparing the variances of three or more groups.
(C) When assessing if observed frequencies match expected frequencies.
(D) When comparing the means of two groups.

290. What does the significance level, alpha (α), represent in hypothesis testing?
(A) The threshold probability for deciding to reject the null hypothesis.
(B) The probability of correctly rejecting the null hypothesis.
(C) The probability of observing a certain result.
(D) The confidence that the true population parameter is in a given interval.

Direction : Please read the following source carefully.

The development of environmental models is a key approach for understanding, simulating, and predicting the behavior of complex

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(A) Interval scale
(B) Nominal scale
(C) Ratio scale
(D) Ordinal scale

Direction : Please read the following source carefully.

Descriptive statistics are fundamental in environmental data analysis for summarizing key features of a dataset. Measures of central tendency and dispersion are the two primary categories of such statistics. Measures of central tendency aim to identify a single value that best represents the center of a distribution. The most common measures are the mean (the arithmetic average), the median (the middle value in an ordered dataset), and the mode (the most frequently occurring value). The choice of measure depends on the data's distribution; for instance, the mean is highly sensitive to extreme values or outliers, whereas the median is more robust. Measures of dispersion, on the other hand, describe the spread or variability of the data points around the central value. Key measures include the range, variance, and standard deviation. While variance quantifies the average squared deviation from the mean, the standard deviation, its square root, is more commonly reported as it is in the same units as the original data. A related but distinct concept is the standard error of the mean. It is not a measure of dispersion within the sample itself, but rather an estimate of the variability of sample means if multiple samples were taken from the same population, thus indicating the precision of the sample mean as an estimate of the population mean.

Based on the above source, attempt the following five questions.

256. In a dataset of river pollution levels, a few data points are extremely high due to an industrial spill. Which measure of central tendency would provide the most reliable representation of the typical pollution level?
(A) The mean
(B) The median
(C) The mode
(D) The standard deviation

257. What is the primary purpose of calculating measures of dispersion for a dataset?
(A) To identify the central value of the data
(B) To determine the most frequently occurring value
(C) To estimate the population mean from a sample
(D) To quantify the spread of data points around the center

258. How does the standard error of the mean differ from the standard deviation of a sample?
(A) Standard error measures the variability of sample means, while standard deviation measures the spread of individual data points in a sample.
(B) Standard error measures the spread of data within a sample, while standard deviation measures the precision of the sample mean.
(C) Standard error is the square of the standard deviation.
(D) Standard error is only applicable to normally distributed data, while standard deviation is not.

259. A researcher reports that the standard deviation of daily temperature readings is 5°C. What does this value represent?
(A) The average temperature for the period
(B) The difference between the highest and lowest temperature
(C) The typical deviation of a daily temperature reading from the mean temperature
(D) The error in the measurement of the mean temperature

260. Which of the following statements about measures of central tendency is most accurate according to the passage?
(A) The mean is calculated as the arithmetic average and is sensitive to extreme values.
(B) The mean, median, and mode will always have the same value in any dataset.
(C) The mean is the most robust measure against the influence of outliers.
(D) The mode represents the middle value in a sorted dataset.

Direction : Please read the following source carefully.

Beyond central tendency and dispersion, the shape of a data distribution is described using moments. Moments are a set of statistical parameters that

remains a fundamental concept for understanding predator-prey interactions. In contrast, Leslie's matrix model offers a different approach by focusing on age-structured population growth. It is a discrete model that uses matrix algebra to project a population's future size and age distribution. The core of the model is the Leslie matrix, which contains age-specific survival rates (the probability of surviving from one age class to the next) and fecundity rates (the average number of offspring produced by an individual in each age class). By repeatedly multiplying this matrix by a vector representing the current population's age structure, one can forecast the population's composition over discrete time intervals, making it invaluable for conservation and management of species where age is a critical factor.

Based on the above source, attempt the following five questions.

296. What type of ecological relationship is the Lotka-Volterra model primarily used to describe?
(A) Commensalism
(B) Competition between two species for the same resource
(C) Age-structured population growth
(D) Predator-prey interactions

297. What is the key characteristic of Leslie's matrix model that distinguishes it from the Lotka-Volterra model?
(A) It incorporates the age structure of a single population.
(B) It is a continuous model based on differential equations.
(C) It focuses on interactions between two different species.
(D) It assumes the population growth rate is constant for all individuals.

298. The Leslie matrix itself contains which critical pieces of information for population projection?
(A) Predator efficiency and prey growth rate
(B) Age-specific survival and fecundity rates
(C) The total population size and carrying capacity
(D) The spatial distribution of the population

299. The Lotka-Volterra model is mathematically represented as a pair of:
(A) Linear regression equations
(B) First-order nonlinear differential equations
(C) Chi-square statistics
(D) Matrix multiplication operations

300. An ecologist studying a threatened turtle species wants to predict how the population will change over the next 50 years, considering the different survival and reproductive rates of juveniles, sub-adults, and adults. Which model would be most suitable for this task?
(A) Leslie's matrix model
(B) Lotka-Volterra model
(C) Simple linear regression model
(D) A correlation analysis

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(A) It is always positively skewed.
(B) It is used for testing relationships between categorical variables.
(C) It has heavier tails to account for uncertainty in small samples.
(D) It is defined by two separate degrees of freedom.

280. An ecologist wishes to test whether there is a statistically significant association between the presence of a certain lichen (present/absent) and the type of rock substrate (granite/limestone/sandstone). The analysis would most appropriately use a test based on the:
(A) F-distribution
(B) t-distribution
(C) Normal distribution
(D) Chi-square (χ^2) distribution

Direction : Please read the following source carefully.

In environmental studies, understanding the relationships between variables is crucial. Correlation and regression are two distinct but related statistical techniques used for this purpose. Correlation analysis measures the strength and direction of the linear association between two continuous variables. The result is a single value, the correlation coefficient (r), which ranges from -1 to +1. A value of +1 indicates a perfect positive linear relationship, -1 indicates a perfect negative linear relationship, and 0 indicates no linear relationship. It is critical to remember that correlation does not imply causation; it merely quantifies the degree to which two variables move together. Regression analysis, on the other hand, goes a step further by aiming to model this relationship. Its primary purpose is to predict the value of a dependent (or response) variable based on the values of one or more independent (or predictor) variables. A simple linear regression model involves one independent variable, whereas a multiple regression model incorporates two or more independent variables to explain the variance in the dependent variable. For example, regression could be used to model and predict the concentration of dissolved oxygen in a river based on water temperature and flow rate. Unlike correlation, regression produces an equation that defines the line or plane of best fit for the data.

Based on the above source, attempt the following five questions.

281. What is the fundamental distinction between correlation and regression analysis?
(A) Correlation measures the strength of a linear association, while regression models the relationship to make predictions.
(B) Correlation uses two variables, while regression can only use one.
(C) Correlation produces an equation, while regression produces a single coefficient.
(D) Correlation implies causation, while regression does not.

282. An environmental scientist finds a correlation coefficient of -0.85 between water temperature and the population of a certain cold-water fish species. What does this value indicate?
(A) A very weak relationship between temperature and fish population.
(B) A strong negative linear relationship, where higher temperatures are associated with lower fish populations.
(C) As water temperature increases, the fish population tends to increase.
(D) The change in water temperature causes the change in fish population.

283. A researcher develops a model to predict soil erosion (in tons/hectare) using rainfall intensity, slope steepness, and vegetation cover as inputs. What type of statistical model is this?
(A) Simple correlation
(B) Multiple regression
(C) Simple linear regression
(D) Chi-square analysis

284. A common and critical misinterpretation that one must avoid when using correlation analysis is:
(A) Concluding that a strong correlation between two variables proves a cause-and-effect relationship.
(B) Assuming a coefficient of 0 means there is no relationship of any kind.
(C) Believing that the correlation coefficient is always a positive number.
(D) Thinking that correlation can only be applied to categorical data.

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provides a more accurate reflection of the central location for skewed income data.

9. (A) P-3, Q-4, R-2, S-1
Scales of measurement provide varying levels of information. The nominal scale classifies data into categories without any inherent order. The ordinal scale adds a ranking or sequence to these categories. The interval scale introduces equal distances between values but lacks a true zero point. Finally, the ratio scale possesses both equal intervals and an absolute zero, allowing for the calculation of meaningful ratios between different measured quantities.

10. (A) Kurtosis
Measures of dispersion, such as range, standard deviation, and quartile deviation, describe the spread or variability within a dataset. They quantify how much the data points differ from each other or from a central value. Conversely, kurtosis is a measure of the shape of a distribution, specifically focusing on the peakedness and the weight of the tails. It does not measure the spread or dispersion of the data.

11. (D) It decreases, because the sample mean becomes a more precise estimate of the population mean.
The standard error of the mean represents the standard deviation of the sampling distribution. It is calculated by dividing the population standard deviation by the square root of the sample size. As the sample size increases, the denominator of this formula grows, leading to a smaller standard error. A smaller standard error indicates that the sample mean is a more reliable and precise estimator of the true population.

12. (B) III and IV only
Statistical variables are classified into distinct types based on their properties. Tree height is a continuous variable because it can take any value within a range. Qualitative variables are known as attributes because they represent non-numeric categories. In contrast, the number of bird species is a discrete variable because it involves counting individuals. Similarly, soil pH is generally considered continuous, and discrete variables cannot take every value.

13. (C) Standard error
When multiple samples are drawn from a population, the means of those samples form their own distribution, known as a sampling distribution. The standard deviation of this specific distribution is called the standard error. It serves as a measure of the precision of the sample statistic. A lower standard error suggests that the sample mean is likely very close to the actual value of the entire population.

14. (D) 4
In statistics, the mode is the specific value that appears most frequently in a given set of observations. To find the mode in this dataset, one must count the occurrences of each number. The value four appears three times, while the values two and five appear once, and the value three appears twice. Since four has the highest frequency of occurrence, it is identified as the mode.

15. (A) I, III, IV, II
Calculating the standard deviation involves a systematic sequence of mathematical operations. First, the arithmetic mean is determined by averaging all data points. Next, the deviation of each individual point from this mean is squared. These squared values are then averaged to find the variance. Finally, taking the square root of the variance yields the standard deviation. This logical progression ensures the measure accurately reflects the spread of data.

16. (A) Both Statement I and Statement II are correct.
Kurtosis describes the shape and tail behavior of a probability distribution. A leptokurtic distribution is characterized by a higher peak and thicker tails compared to a normal distribution, indicating a higher frequency of extreme values. A platykurtic distribution is flatter with thinner tails and has a kurtosis value less than three. Both statements accurately reflect these statistical definitions used to compare distributions against the benchmark of normality.

17. (B) It uses all the data points in its calculation.
The range is the simplest measure of dispersion, calculated by subtracting the minimum value from the maximum value in a dataset. While it provides a quick overview of the total spread, it is severely limited because it ignores all intermediate data points. Consequently, the

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together; they do not prove that one variable causes the other to change. Establishing causality requires experimental control and a theoretical basis beyond mere statistical association between two variables.

67. (C) To project the future size and age distribution of a population.
Leslie's matrix model is a foundational tool in population ecology for studying populations with discrete age classes. Its primary purpose is to project how a population will grow and how its age structure will evolve over time. By incorporating age-specific birth and survival rates, the model allows researchers to predict long-term trends, such as whether a population will increase, decrease, or reach a stable age distribution, providing critical information for conservation and management.

68. (D) Mean = Median = Mode.
In a perfectly symmetrical distribution, such as a normal distribution, the data is balanced around its center point. Because there is no skewness, the tail on the left is a mirror image of the tail on the right. This symmetry results in the arithmetic mean, the middle value or median, and the most frequent value or mode all occurring at the same point. This alignment is a key characteristic used to identify symmetric distributions in statistics.

69. (C) Zero
Moments about the mean, or central moments, are used to describe the shape of a distribution. The first central moment is calculated by taking the sum of the differences between each data point and the arithmetic mean, then dividing by the total number of points. Mathematically, the sum of these deviations always equals zero because the mean is the balancing point of the dataset. Therefore, the first moment about the mean is always zero for any distribution.

70. (B) The variance between groups to the variance within groups.
The F-test in a one-way Analysis of Variance evaluates whether the means of several groups are equal. It does this by calculating the ratio of the variance observed between the different groups to the variance observed within each individual group. If the variability between the group means is significantly larger than the variability within the groups, the F-statistic will be high, leading to the rejection of the null hypothesis that all group means are equal.

71. (D) Ordinal scale
The ordinal scale of measurement is used for data that can be categorized and placed into a meaningful order or rank. In this case, air quality levels of Good, Moderate, and Poor have a clear hierarchical relationship. However, the exact mathematical difference between Good and Moderate may not be the same as the difference between Moderate and Poor. Because the categories have an order but lack equal intervals, they represent an ordinal scale.

72. (A) Both A and R are true and R is the correct explanation of A.
Many environmental datasets are positively skewed because concentrations of chemicals or pollutants cannot be negative and often contain a few very high values. The log-normal distribution is ideal for modeling this behavior. By performing a logarithmic transformation on such data, the resulting values often follow a normal distribution. This is beneficial because most standard statistical tests are designed for normally distributed data, making analysis more straightforward and reliable for researchers and environmental scientists.

73. (C) Attributes are qualitative, while variables are quantitative.
The fundamental distinction between attributes and variables lies in the nature of the data they represent. Attributes refer to qualitative characteristics that cannot be naturally expressed as numbers, such as gender, species name, or soil type. Variables, on the other hand, are quantitative characteristics that can be measured or counted numerically, such as height, temperature, or population size. Recognizing this difference is essential for choosing the correct statistical methods for data analysis and interpretation.

74. (A) 0.3
In probability theory, the sum of the probabilities of all mutually exclusive and exhaustive outcomes in a sample space must equal one. If there are only two possible outcomes, such as a sunny day or not a sunny day, they are considered complements of each other. To find the probability of the

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the mean, median, and mode are all located at the center and are equal to each other. The spread of the curve is determined by the standard deviation. While a standard normal distribution has a mean of zero and a standard deviation of one, normal distributions in general can have any mean.

27. (D) ANOVA
When a researcher needs to compare the means of a continuous dependent variable across more than two categorical groups, Analysis of Variance is the most appropriate statistical tool. In this scenario, the soil type acts as the independent variable with three levels. ANOVA determines if the observed variations between the group means are larger than the variations within the groups, indicating whether the soil type significantly affects plant growth.

28. (B) I, II, IV, and V
Probability distributions have distinct characteristics. The Binomial distribution models independent trials with two outcomes, while the Poisson distribution has equal mean and variance. As degrees of freedom increase, the t-distribution converges toward the normal distribution. Log-normal distributions effectively model skewed environmental data. However, the standard normal distribution is defined by a mean of zero and a standard deviation of one, which makes the third statement in the list false.

29. (C) The slope, or the change in Y for a one-unit change in X.
In the context of a simple linear regression equation, the coefficient represented by the letter b is known as the slope. It quantifies the expected change in the dependent variable for every single unit of increase in the independent variable. If the slope is positive, the variables move in the same direction. If it is negative, they move in opposite directions. The slope determines the steepness of the regression line.

30. (D) Predator-prey dynamics.
The Lotka-Volterra equations consist of a pair of first-order, non-linear differential equations frequently used to describe the dynamics of biological systems where two species interact. Specifically, the model characterizes the relationship between a predator population and a prey population. It illustrates how the populations fluctuate over time, often resulting in cyclical oscillations where the abundance of one species directly influences the birth and death rates of the other.

31. (A) Validation
Validation is a crucial step in environmental modeling that involves testing a model's predictive accuracy using a dataset that was not used during its initial development or calibration phase. This process ensures that the model can generalize its findings to new situations rather than simply fitting existing data perfectly. Successful validation provides confidence that the model is a reliable representation of reality and can be used for future forecasting.

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32. (A) Both Statement I and Statement II are correct.
In hypothesis testing, two types of errors can occur. A Type I error happens when a researcher incorrectly rejects a null hypothesis that is actually true, often referred to as a false positive. A Type II error occurs when the researcher fails to reject a null hypothesis that is actually false, known as a false negative. Understanding both errors is vital for interpreting the reliability and power of statistical conclusions in scientific research.

33. (B) The sample sizes of the two groups are equal.
The independent samples t-test relies on several fundamental assumptions to ensure valid results. These include the independence of observations, the normal distribution of data within each group, and the equality of variances between the groups. However, the test does not require the sample sizes of the two groups to be equal. It can be mathematically adjusted to account for different numbers of observations in each group being compared.

34. (A) Both A and R are true and R is the correct explanation of A.
The Chi-square test is a non-parametric statistical method specifically designed for analyzing categorical data. It evaluates whether there is a significant association between variables by comparing the observed frequencies in different categories to the frequencies that would be expected under the null hypothesis. Because the test relies on these frequency comparisons

range is highly sensitive to extreme outliers and does not provide information about how the data is distributed between the two extreme ends.

18. (B) Both A and R are true but R is not the correct explanation of A.
Moments about the mean are used to characterize the properties of a distribution. The second central moment is mathematically defined as the variance, which measures the spread of data. Higher moments, such as the third and fourth, describe skewness and kurtosis. While both statements are factually accurate, the description of how moments define shape does not explain why the second moment specifically represents the variance.

19. (C) 0
Standard deviation is a measure of the amount of variation or dispersion in a set of values. If every single measurement in a dataset is identical, there is no variation at all between the observations. Since all values are exactly five, they do not deviate from the mean, which is also five. In such a scenario, the calculation of deviations results in zero, leading to a standard deviation of zero.

20. (D) Skewness
Skewness is a statistical measure that quantifies the degree of asymmetry in a probability distribution. A perfectly symmetrical distribution, such as the normal distribution, has a skewness value of zero. If the tail is longer on the right, the distribution is positively skewed, whereas a longer left tail indicates negative skewness. It provides essential information about whether data points are concentrated more on one side of the mean.

21. (A) I, II, and III only
Probability theory is governed by specific axioms. Every probability must be between zero and one, where zero represents impossibility and one represents certainty. The sum of all possible mutually exclusive outcomes in a sample space must equal one. However, if two events are mutually exclusive, they cannot occur at the same time. Therefore, the probability of both occurring is zero, not one, making the fourth statement incorrect.

22. (B) The probability of observing the data, or something more extreme, if the null hypothesis is true.
The p-value is a critical metric in hypothesis testing used to determine statistical significance. It quantifies the likelihood of obtaining the observed sample results, or results even more extreme, under the assumption that the null hypothesis is correct. A very small p-value indicates that the observed data is highly unlikely if the null hypothesis is true, leading researchers to reject it in favor of the alternative hypothesis.

23. (D) Poisson Distribution
The Poisson distribution is a discrete probability distribution used to model the number of times an event occurs within a fixed interval of time or space. It is particularly appropriate for rare events that occur independently and at a constant average rate. Examples include modeling the frequency of mutations in a DNA sequence, radioactive decay events, or the number of lightning strikes in a specific region over a year.

24. (A) A strong negative linear relationship.
The Pearson correlation coefficient ranges from negative one to positive one. A value of zero indicates no linear relationship, while values close to one or negative one represent strong relationships. A coefficient of negative zero point nine signifies a very strong negative linear relationship. This means that as the value of one variable increases, the value of the other variable consistently decreases in a nearly linear fashion.

25. (C) The means of three or more independent groups.
One-way Analysis of Variance is a statistical technique used to determine if there are any statistically significant differences between the means of three or more independent groups. It tests the null hypothesis that all group means are equal against the alternative that at least one group mean is different. This test is essential when researchers want to compare multiple treatments or conditions simultaneously rather than performing multiple t-tests.

26. (A) It is symmetric and bell-shaped.
The normal distribution is a continuous probability distribution characterized by a symmetric, bell-shaped curve. In this distribution,

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those resulting intervals would capture the true population mean. It does not state the probability that a specific calculated interval contains the mean, nor the percentage of individual data points.

43. (D) Kurtosis
Kurtosis is a statistical measure used to describe the distribution of observed data around the mean. Specifically, it quantifies the peakedness or flatness of the distribution's peak and the thickness of its tails relative to a normal distribution. High kurtosis indicates a sharp peak and heavy tails, while low kurtosis signifies a flatter peak and thinner tails. This measure helps researchers understand the frequency of extreme values in their data.

44. (B) One-way ANOVA
One-way Analysis of Variance is a parametric statistical test that requires the dependent variable to be measured on an interval or ratio scale. It also assumes that the data follow a normal distribution and have equal variances. For data measured on an ordinal scale, such as rankings, non-parametric tests like the Kruskal-Wallis or Friedman tests are appropriate. Using ANOVA for ordinal data violates its fundamental measurement assumptions and can lead to invalid conclusions.

45. (C) Normal distribution
The normal distribution is a fundamental probability distribution in statistics characterized by its symmetric, bell-shaped curve. One of its defining properties is its kurtosis value. In many statistical contexts, the kurtosis of a normal distribution is exactly three. When using excess kurtosis, which is kurtosis minus three, the value for a normal distribution becomes zero. This standard serves as a baseline for comparing the peakedness of all other probability distributions.

46. (D) The prey population grows exponentially without limit.
In the basic Lotka-Volterra predator-prey model, several simplifying assumptions are made. One key assumption is that the prey population has an unlimited food supply and its growth is only restricted by predation. Consequently, if the predators are removed from the system, the model predicts that the prey population will grow exponentially at its intrinsic rate of increase. This model does not include a carrying capacity, which would normally limit growth in reality.

47. (A) Two variances
The F-distribution is a continuous probability distribution that arises frequently in the context of the Analysis of Variance. The F-statistic is calculated as the ratio of two independent estimates of population variance. Specifically, it compares the variance between group means to the variance within the groups. This ratio helps determine if the variability observed between groups is significantly larger than what would be expected by chance, indicating differences in group means.

48. (A) Both Statement I and Statement II are correct.
The Chi-square distribution is a non-symmetric distribution that only takes non-negative values. For low degrees of freedom, it is highly positively skewed with a long tail to the right. As the degrees of freedom increase, the distribution changes shape and gradually becomes more symmetric. Eventually, for very large degrees of freedom, it closely approximates the normal distribution. Both statements accurately describe the fundamental geometric and mathematical properties of this important statistical distribution.

49. (B) A correlation analysis
Correlation analysis is the most appropriate initial statistical tool for investigating the strength and direction of a linear association between two continuous variables. In this case, the amount of fertilizer and the concentration of nitrates are both numeric and continuous. By calculating a correlation coefficient, the agency can determine if an increase in fertilizer use is consistently associated with an increase in nitrate levels, providing a basis for further regression modeling if needed.

50. (A) Median
The median is a measure of central tendency that represents the exact middle value in a dataset when the observations are arranged in numerical order. It effectively divides the distribution into two equal halves, with 50% of the values lying above it and 50% below it. Unlike the mean, the median is not influenced by extreme

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outliers, making it a highly useful measure for describing the center of skewed or asymmetrical distributions.

51. (A) II, IV, I, III
Scales of measurement are categorized by the amount of information they provide. The nominal scale is the simplest, providing only labels. The ordinal scale adds ranking. The interval scale provides equal distances between values but lacks a true zero. The ratio scale is the most informative, as it includes a true zero point, allowing for meaningful comparisons of magnitudes. Therefore, the correct hierarchy of information is nominal, followed by ordinal, interval, and ratio.

52. (D) The proportion of variance in the dependent variable that is predictable from the independent variable(s).
The coefficient of determination, denoted as R-squared, is a key statistic in regression analysis. It quantifies the goodness-of-fit of a model by calculating the percentage of the total variation in the dependent variable that can be explained by the independent variables. A value of one indicates a perfect fit, while zero indicates the model explains none of the variability. It provides a measure of how well the regression line represents the data.

53. (C) Reject the null hypothesis.
In hypothesis testing, the decision to reject the null hypothesis is based on comparing the calculated test statistic to a critical value determined by the significance level. If the absolute value of the computed t-statistic exceeds the critical t-value, it indicates that the observed result is unlikely to have occurred by chance under the null hypothesis. Therefore, the researcher has sufficient evidence to reject the null hypothesis and support the alternative hypothesis.

54. (A) I, II, III, and V
Hypothesis testing involves several core components. The null hypothesis represents no effect, while the alternative is what researchers seek to support. The significance level defines the probability of a Type I error, and the test statistic is calculated from sample data. However, the p-value is calculated assuming the null hypothesis is true, not the alternative. Thus, the first, second, third, and fifth statements are correct, while the fourth statement contains a fundamental error.

55. (D) The effect of two or more independent variables and their interaction.
While one-way Analysis of Variance examines the influence of a single categorical independent variable on a continuous dependent variable, two-way ANOVA expands this by considering two factors simultaneously. This approach allows researchers to evaluate not only the individual main effects of each factor but also the interaction effect. An interaction occurs when the influence of one independent variable on the outcome changes depending on the level of the second independent variable being studied.

56. (C) A is true but R is false.
The Leslie matrix model is a powerful tool for population projection that utilizes age-specific survival and fecundity rates. While the assertion correctly identifies that the matrix contains these parameters, the reason provided is incorrect. One of the primary advantages of the Leslie model is that it projects both the total population size and the future age distribution over time. It can even demonstrate how a population eventually reaches a stable age distribution under constant conditions.

57. (C) A discrete variable
A discrete variable is a type of quantitative variable that can only take on specific, separate values, which are usually obtained through counting. These values are often integers, such as the number of children in a family or the number of species in a habitat. Unlike continuous variables, which can take any value within a range, discrete variables have gaps between their possible values, meaning they cannot represent fractions or infinitely precise measurements.

58. (A) The probability of success is constant for each trial.
The Binomial distribution is used to model the number of successes in a fixed number of independent trials. For this distribution to be valid, several conditions must be met: there must be only two possible outcomes per trial, the trials must be independent, and the probability of success must remain the same for every single trial. If the probability changes between trials, the

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Binomial distribution can no longer accurately represent the probability of the total outcomes.

59. (A) P-3, Q-1, R-2, S-4
Understanding errors and power is essential in hypothesis testing. A Type I error involves rejecting a true null hypothesis, and its probability is denoted by the significance level. A Type II error occurs when one fails to reject a false null hypothesis. The power of a test is the probability of correctly rejecting a false null hypothesis, which represents the test's ability to detect an effect when one truly exists in the population.

60. (B) The population standard deviation is unknown and the sample size is small.
The t-distribution is used for hypothesis testing when the population standard deviation is unknown and must be estimated from a small sample. In such cases, the t-distribution accounts for the additional uncertainty in the estimation of the variance by having heavier tails than the normal distribution. As the sample size increases, the estimate of the standard deviation becomes more precise, and the t-distribution eventually converges to the standard normal distribution used for larger samples.

61. (C) Disregarding all assumptions to ensure generalizability.
Developing an environmental model involves several rigorous stages, including formulation based on established theories, calibration using specific data to tune parameters, and validation against independent data to test accuracy. Assumptions are a fundamental part of modeling because they simplify complex reality to make it manageable. Disregarding these assumptions would not improve generalizability; instead, it would make the model scientifically unsound and impossible to interpret. Valid models must explicitly state and respect their underlying assumptions.

62. (B) I, III, and IV only
Measures of dispersion provide insights into data variability. The variance is indeed the square of the standard deviation, and the coefficient of variation is a relative measure. Furthermore, increasing the sample size reduces the standard error of the mean, improving precision. However, the range is actually very sensitive to outliers because it only uses the two extreme values. In contrast, the interquartile range is more robust as it focuses on the middle fifty percent.

63. (A) Discrete variable
A variable is classified as discrete when its possible values are countable and separate, often represented by integers. Since you cannot have a fraction of a car passing a point, the number of cars is a classic example of a discrete variable. This contrasts with continuous variables, like time or distance, which can be measured with infinite precision. The count of objects or events always falls under the category of discrete data in statistics.

64. (B) Pearson Correlation
Pearson Correlation is the standard statistical method used to measure the strength and direction of the linear relationship between two continuous variables. Since both plant density and soil moisture are measured on continuous scales, calculating the Pearson coefficient will provide a value between negative one and positive one. This value indicates how closely the variables move together in a straight-line fashion, helping ecologists understand the potential association between environmental factors and species distribution.

65. (B) Two categorical variables.
The Chi-square test for independence is a non-parametric statistical procedure used to determine if there is a significant relationship between two categorical variables. For example, it could be used to see if habitat type is independent of the presence of a specific animal species. The test compares the observed frequencies in each combination of categories against the frequencies that would be expected if the variables were completely unrelated, helping identify significant patterns in qualitative data.

66. (C) Statement I is correct but Statement II is incorrect.
Regression models are powerful tools for forecasting because they provide a mathematical equation that can predict the value of a dependent variable based on independent variables. However, a significant regression result does not establish a causal relationship. Correlation and regression only show that variables change

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moment, statisticians can determine whether a distribution has more or fewer extreme values than a standard normal distribution.

83. (C) Binomial
The Binomial distribution is the most suitable probability distribution for modeling scenarios where there are a fixed number of independent trials, each resulting in only two possible outcomes, such as success or failure. For this distribution to apply, the probability of success must remain constant across all trials. Common applications include predicting the number of germinating seeds in a batch or the number of defective items produced in a manufacturing run with a known error rate.

84. (A) I, II, and IV only
The normal distribution is defined by its mean and standard deviation. It is perfectly symmetric, resulting in a skewness of zero, and has a kurtosis of three. The curve is asymptotic, meaning it approaches but never touches the horizontal axis. However, the empirical rule states that approximately sixty-eight percent of the data lies within one standard deviation, while ninety-nine point seven percent lies within three standard deviations. Therefore, the third statement in the list is incorrect.

85. (C) Mean < Median < Mode
In a negatively skewed distribution, the data is clustered toward the high end, with a long tail stretching toward the lower values on the left. These low outliers pull the arithmetic mean down more than they affect the median or the mode. As a result, the mean typically has the lowest value, followed by the median, which represents the middle point. The mode, representing the most frequent value, remains at the peak of the distribution.

86. (B) It makes the interval wider.
The width of a confidence interval for the mean is determined by the sample size and the variability of the data. The formula for the confidence interval involves dividing the standard deviation by the square root of the sample size. Consequently, a very small sample size increases the standard error, which leads to a greater margin of error. This increased uncertainty results in a wider confidence interval, reflecting less precision in the estimate of the population mean.

87. (D) F-test
The F-test is a statistical procedure specifically designed to compare the variances of two independent populations. It calculates the ratio of the two sample variances and compares this value to a critical value from the F-distribution. This test is often used as a preliminary step before conducting an independent samples t-test to determine if the assumption of equal variances is met. If the variances are significantly different, adjusted versions of the t-test must be used.

88. (C) Statement I is correct but Statement II is incorrect.
Extrapolation involves using a regression model to predict values for the dependent variable outside the range of the independent variables used to create the model. While this can be done, it is generally considered much less reliable than interpolation, which predicts values within the observed range. This is because the linear relationship established by the model may not hold true for extreme values, leading to potentially significant errors in the predicted outcomes during extrapolation.

89. (C) The average number of female offspring born to a female of age class i
Leslie's matrix model is used to project the growth of populations with discrete age classes. A critical component of this matrix is the fecundity rate, often denoted as Fi. These values are placed in the first row of the matrix and represent the average number of female offspring produced by a female during a specific age interval. Since the model typically tracks only females, these rates are essential for calculating how many new individuals enter the population.

90. (A) Chi-square goodness-of-fit test
The Chi-square goodness-of-fit test is a statistical method used to determine how well a set of observed sample data matches a specific theoretical probability distribution. In this case, the ecologist can use the test to compare the actual counts of insects on plants to the counts that would be expected if the distribution were Poisson. If the differences between the observed and expected frequencies are large, the null

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complement, you subtract the known probability from one. Therefore, subtracting zero point seven from one gives a probability of zero point three.

75. (A) II, IV, III, I
Developing a regression model follows a logical chronological sequence. First, the researcher must collect data for both the independent and dependent variables. Next, the model is built by fitting a regression line to this data. Once the model is established, it must be validated using a new, independent dataset to ensure its accuracy. Finally, after successful validation, the model can be used for forecasting future values of the dependent variable based on new inputs.

76. (B) The effect of one independent variable on the dependent variable depends on the level of the other independent variable.
In a two-way Analysis of Variance, an interaction effect occurs when the influence of one factor on the outcome is not consistent across all levels of the second factor. For example, a fertilizer might significantly increase growth in wet soil but have no effect in dry soil. This means the factors do not act independently; their combined effect is different from what would be expected by simply adding their individual effects together, requiring careful interpretation of results.

77. (C) It includes a carrying capacity for the prey population.
The basic Lotka-Volterra predator-prey model is characterized by its simplicity. It assumes that the prey population grows exponentially in the absence of predators and that the predator population declines exponentially in the absence of prey. However, a major limitation and an incorrect assumption often attributed to the simple model is the inclusion of a carrying capacity. In the basic equations, prey growth is only limited by predation, which often leads to unstable population oscillations.

78. (C) III, IV, and V
Statistical concepts have specific definitions. The t-distribution is flatter and possesses heavier tails compared to the normal distribution. ANOVA is a versatile tool used to compare means across two or more groups. Furthermore, a ratio scale is defined by having a true zero point, which is essential for meaningful comparisons of magnitude. However, correlation never implies causation, and the standard error is a measure of variability, not a measure of central tendency like the mean.

79. (A) The result is statistically significant, and we reject the null hypothesis.
Statistical significance is determined by comparing the p-value to the pre-determined significance level. If the p-value is less than or equal to the significance level, the observed results are considered unlikely to have occurred by chance under the null hypothesis. In this case, zero point zero two is less than zero point zero five. Therefore, the researcher concludes that the fertilizer has a statistically significant effect and rejects the null hypothesis of no effect.

80. (B) 21.0
A simple linear regression equation allows for the prediction of a dependent variable based on an independent variable. By substituting the value of the independent variable into the equation, we can calculate the expected outcome. In this specific model, multiplying five by two point one equals ten point five. Adding this value to the intercept of ten point five results in a total predicted value of twenty-one. This demonstrates the predictive application of regression models.

81. (B) P-4, Q-2, R-1, S-3
Variables are classified into four main types based on their measurement properties. The number of rainy days is a discrete variable because it involves counting. Temperature in Kelvin is a continuous variable as it can take any value. Tree species are nominal because they are qualitative categories without order. Finally, air quality rankings are ordinal because they represent categories with a specific hierarchy. Correctly identifying these types is fundamental for applying the appropriate statistical analysis methods.

82. (A) Kurtosis
Moments about the mean are statistical measures that describe the characteristics of a distribution's shape. The first moment is zero, the second moment is the variance, and the third moment measures skewness. The fourth moment is specifically used to calculate kurtosis, which quantifies the peakedness and tail weight of the distribution. By analyzing the fourth

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to determine if deviations are statistically significant, the reason provided perfectly explains the primary application of the assertion.

35. (C) -1 to +1
The Pearson correlation coefficient is a standardized measure of the strength and direction of the linear relationship between two continuous variables. Its value is mathematically constrained to stay between negative one and positive one. A value of positive one indicates a perfect positive linear relationship, while negative one indicates a perfect negative relationship. A value of zero suggests that no linear association exists between the variables being analyzed by the researcher.

36. (D) Sampling frame
In sampling theory, a sampling frame is a comprehensive list or database of all elements or individuals within a target population from which a sample is actually drawn. It provides the operational definition of the population and is essential for ensuring that every member has a known probability of being selected. An incomplete or inaccurate sampling frame can introduce bias, leading to a sample that does not truly represent the intended population.

37. (A) P-4, Q-1, R-2, S-3
Different statistical tests are designed for specific types of data and research questions. The t-test is used to compare means between two groups, while ANOVA extends this comparison to more than two groups. The Chi-square test is appropriate for examining associations between categorical variables. Regression analysis is used to model and examine the linear relationship between continuous variables. Correctly matching these tests to their applications is fundamental for accurate data analysis.

38. (B) Log-normal
Many types of environmental data, such as the concentration of pollutants in soil or air, are characterized by a lower bound of zero and the presence of occasional extremely high values. This results in a distribution that is skewed to the right. The log-normal distribution is frequently used to model such data because the logarithms of the values follow a normal distribution, effectively handling the skewness and non-negative nature of these measurements.

39. (D) n1 + n2 - 2
Degrees of freedom represent the number of independent values that can vary in a statistical calculation. For an independent samples t-test where equal variances are assumed, the total degrees of freedom are calculated by adding the sizes of both samples and subtracting two. This subtraction accounts for the two means estimated from the data. This value is critical for determining the correct critical value from the t-distribution table to assess significance.

40. (B) I, II, and IV only
Environmental modeling involves various processes and model types. Simple regression uses one predictor, while multiple regression incorporates several. Forecasting uses validated models to predict future events. However, calibration is the specific process of adjusting model parameters to fit observed data, whereas validation is the independent check of that fit. Therefore, the statement describing validation as the adjustment of parameters is incorrect, while the other three statements correctly describe modeling concepts.

41. (C) Predict the growth of a population with a defined age structure.
Leslie's matrix model is a discrete-time, age-structured population model used extensively in ecology. It utilizes a matrix containing age-specific survival and fecundity rates to project how a population will change over time. By accounting for the different reproductive outputs and survival probabilities of various age classes, the model provides a more detailed and accurate prediction of population growth and age distribution than simpler models that treat all individuals as identical.

42. (A) If we repeat the sampling process many times, 95% of the calculated confidence intervals would contain the true population mean.
A confidence interval is an interval estimate of a population parameter. A 95% confidence level describes the reliability of the estimation procedure. It means that if the same population were sampled many times and an interval was calculated for each sample, approximately 95% of

hypothesis that the data follows that distribution is rejected.

91. (A) Both A and R are true and R is the correct explanation of A.
A paired t-test is used when measurements are taken from the same individuals or naturally matched pairs, such as before-and-after studies. By focusing on the differences within each pair, the test effectively controls for variability between different subjects. This reduction in the background noise or error variance increases the statistical power of the test, making it more likely to detect a true effect compared to an independent samples t-test that treats all observations as unrelated.

92. (B) 1
For any continuous probability distribution, the total area under the probability density curve represents the sum of all possible probabilities in the sample space. According to the fundamental axioms of probability theory, the total probability for any random experiment must equal exactly one. This ensures that the entire range of potential outcomes is accounted for. Consequently, when you integrate the probability density function over its entire range, the resulting value will always be one.

93. (C) Ratio
The ratio scale of measurement provides the highest level of information because it possesses all the properties of the nominal, ordinal, and interval scales, along with a unique characteristic: a true zero point. This absolute zero signifies the complete absence of the measured attribute, such as height, weight, or absolute temperature. Because of this zero point, the ratio scale allows for meaningful multiplication and division, enabling researchers to calculate exactly how many times larger one value is than another.

94. (D) 0 to 1
The coefficient of determination, denoted as R-squared, measures the proportion of variance in the dependent variable that is explained by the independent variables in a regression model. Because it is calculated as the square of the correlation coefficient or as a ratio of explained variation to total variation, its value is always non-negative and cannot exceed one. A value of one indicates a perfect fit, while zero means the model explains no variation in the data.

95. (A) The overall effect of one independent variable on the dependent variable, averaging over the levels of the other independent variable
In the context of a two-way Analysis of Variance, researchers examine multiple influences on a dependent variable. A main effect refers to the consistent influence of a single independent variable while ignoring the levels of the other factor. For example, if studying the effects of sunlight and water on plant growth, the main effect of sunlight is the overall difference in growth between high and low light conditions, regardless of how much water each plant received during the experiment.

96. (B) The rate of encounter between predators and prey is proportional to the product of their populations
The Lotka-Volterra predator-prey model is built on several simplifying assumptions. One of the most fundamental is the principle of mass action, which states that the rate at which predators capture prey is directly proportional to the frequency of their encounters. This encounter rate is mathematically represented as the product of the prey population size and the predator population size, multiplied by a constant. This linear interaction term is what drives the cyclical dynamics observed in the model.

97. (B) It is flatter than a normal distribution with lighter tails
Kurtosis describes how the tails and peak of a distribution compare to a normal distribution. A platykurtic distribution is characterized by having a lower, flatter peak and thinner tails. This indicates that the data points are spread out more evenly and that extreme values occur less frequently than they would in a normal distribution. In many statistical packages, a platykurtic distribution is identified by a negative excess kurtosis value, reflecting its deviation from the bell-shaped curve.

98. (A) Committing a Type I error
In hypothesis testing, the significance level, denoted by the Greek letter alpha, is a pre-determined threshold set by the researcher. It represents the maximum acceptable probability

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129. (B) Individuals cannot remain in the same age class from one time step to the next.
A Leslie matrix models a population divided into discrete age classes of equal length. The time step used for population projection is identical to the duration of these age intervals. In this system, any individual who survives a single time step must automatically transition into the next, older age class. Because it is impossible for an individual to stay within the same age group after one time interval has passed, the diagonal elements representing self-transitions must be equal to zero.

130. (A) The tail of the distribution is longer on the left side.
Skewness quantifies the asymmetry of a probability distribution around its mean. When a distribution has negative skewness, it means the mass of the data is concentrated on the right side, with a few low-value outliers stretching the distribution toward the left. This creates a longer tail on the negative side of the mean. Consequently, the arithmetic mean is pulled toward these lower values and is typically less than the median and the mode in such distributions.

131. (A) II, IV, III, I
The development of an environmental model follows a systematic chronological workflow. It begins with conceptualization, where the problem is defined and the model's structure is planned. Next, the model is implemented through coding or mathematical formulation. Once the structure is built, calibration is performed to tune the model's parameters using observed data. Finally, validation is conducted by testing the model's predictive performance against an independent dataset to ensure it accurately represents reality before it is used.

132. (D) The upper and lower boundaries of a confidence interval.
A confidence interval is a range of values derived from sample data that is likely to contain the true value of an unknown population parameter. The specific values that define the ends of this range are known as the confidence limits. For example, in a ninety-five percent confidence interval, the lower and upper confidence limits mark the boundaries within which we are ninety-five percent certain the population mean lies. These limits provide a measure of the precision of the estimate.

133. (C) Chi-square goodness-of-fit test
The Chi-square goodness-of-fit test is designed to determine if observed categorical data matches a specific expected distribution. If the researcher wants to test if bird species are uniformly distributed, they are essentially comparing the actual counts in each habitat to the counts that would be expected if each habitat had an equal number of birds. This non-parametric test will determine if the deviations from a uniform distribution are statistically significant or likely due to random sampling variations.

134. (B) P-2, Q-3, R-4, S-1
In statistics, it is standard practice to use Greek letters for population parameters and Roman letters for sample statistics. The population mean is denoted by the Greek letter mu, while the sample mean is represented by the Roman letter x with a bar. Similarly, the population standard deviation uses the Greek letter sigma, whereas the sample standard deviation is symbolized by the Roman letter s. Using these distinct symbols is essential for clear communication and mathematical accuracy in statistical analysis.

135. (D) Decline exponentially to extinction.
The Lotka-Volterra predator-prey model makes several key assumptions about the survival of species. In this model, the predator population is specialized and depends entirely on the prey as its only source of food. If the prey population is removed from the system, the model predicts that the predators will have no resources to sustain themselves. Consequently, the predator population will experience a negative growth rate and will decline exponentially until they eventually reach extinction in that specific environment.

136. (D) Statement I is incorrect but Statement II is correct.
Measures of variability describe how spread out a distribution is. The range is highly unstable because it is based solely on the two most extreme values, which can change significantly with just one new outlier. In contrast, the standard deviation is more stable because it incorporates

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The Leslie matrix is a square matrix used to model population growth in age-structured populations. The first row of this matrix is specifically reserved for fecundity values, which represent the average number of offspring produced by individuals in each age class during a single time step. These values determine how many new individuals will enter the youngest age class in the next generation. All other rows in the matrix describe the survival probabilities of existing individuals as they age.

107. (A) Both A and R are true and R is the correct explanation of A.
In a two-way Analysis of Variance, the interaction effect determines whether the influence of one factor depends on the level of the second factor. If a significant interaction exists, it suggests that the factors are not acting independently, which can make the interpretation of main effects misleading. For example, if a treatment is beneficial in one environment but harmful in another, the average main effect might show no overall change, hiding the true nature of the data's complex relationships.

108. (B) Interquartile Range (IQR)
The interquartile range is a robust measure of dispersion that focuses on the middle fifty percent of a dataset. It is calculated by subtracting the first quartile from the third quartile, thereby effectively ignoring the extreme high and low values. Because it excludes the outliers at both ends of the distribution, the interquartile range provides a much more stable and accurate reflection of the typical spread of data than measures like the range or the standard deviation.

109. (C) Mean Square Between / Mean Square Within
In the Analysis of Variance, the F-statistic is the primary test statistic used to evaluate whether there are significant differences between group means. It is calculated by taking the ratio of the Mean Square Between groups, which represents the variability caused by the different treatments or categories, to the Mean Square Within groups, which represents the random error or inherent variability within each group. A higher ratio indicates that the differences between groups are larger than expected by chance alone.

110. (A) P-3, Q-1, R-2, S-4
Different probability distributions have specific uses in environmental science and statistics. The Binomial distribution models the number of successes in fixed trials, like seed germination. The Poisson distribution is ideal for counting rare, independent events over time or space. The normal distribution describes many natural measurements and measurement errors. Finally, the log-normal distribution is frequently used to model concentrations of pollutants, which are naturally bounded by zero and often exhibit a right-skewed pattern with extreme values.

111. (A) The residual
In regression analysis, the difference between the actual observed value of the dependent variable and the value that is predicted by the regression equation is called the residual. Residuals are essential for assessing the goodness-of-fit of a model. By analyzing the pattern and magnitude of these residuals, researchers can determine if the model's assumptions are met, such as whether the errors are normally distributed and have constant variance, ensuring the reliability of the statistical conclusions.

112. (B) Skewness
Statistical moments provide a mathematical framework for describing the shape of a probability distribution. The first central moment is zero, and the second is the variance. The third central moment is specifically used to quantify skewness, which measures the degree of asymmetry in the distribution. A positive third moment indicates a distribution with a longer right tail, while a negative value suggests a longer left tail. This measure is crucial for understanding how data departs from a symmetric normal distribution.

113. (A) I and II only
Sampling methods are categorized into probability and non-probability techniques. Simple random sampling and stratified sampling are both probability methods that ensure every individual or subgroup has a known chance of selection. However, cluster sampling is often less statistically efficient than simple random sampling for a given sample size, although it is more practical for large areas. Convenience sampling is a non-probability method that does

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The F-ratio, calculated as a ratio of variances, follows the F-distribution. Finally, the Chi-square statistic is used for goodness-of-fit and independence tests and follows the Chi-square distribution. Matching these correctly is essential for determining p-values and making accurate statistical decisions in research.

160. (B) Comparing the blood pressure of a group of patients before and after taking a medication.
A paired t-test is specifically designed for analyzing data where each observation in one set is uniquely linked to an observation in another set. The most common application is a repeated measures design, where the same subjects are measured twice under different conditions, such as before and after a medical treatment. This test focuses on the difference between the two measurements for each individual, which effectively controls for the natural variation that exists between different people in the study.

161. (B) III, II, I
In a negatively skewed distribution, the tail extends toward the lower values on the left side of the scale. This asymmetry causes the arithmetic mean to be pulled toward the tail, making it the smallest value among the three measures. The median represents the middle point and falls between the mean and the mode. The mode, which corresponds to the highest peak of the distribution, remains the largest value. Therefore, the descending order of their values is mode, median, mean.

162. (A) Both A and R are true and R is the correct explanation of A.
It is a fundamental principle in statistics that a strong correlation between two variables does not prove that one variable causes the other. While a correlation shows that the variables change together, this relationship could be the result of a third, unobserved factor known as a confounding variable. This third factor may be independently influencing both of the measured variables, creating a spurious association that disappears once the confounder is accounted for in the analysis.

163. (C) Age-specific survival and fecundity rates.
The Leslie matrix model is a foundational tool in population ecology for studying organisms with discrete age classes. To construct this model, researchers must input specific demographic data for each age group. This includes age-specific survival rates, which represent the probability of an individual surviving to the next age class, and fecundity rates, which represent the average number of offspring produced. These parameters are essential for projecting the future size and age structure of the population.

164. (D) Approximately 95%.
The normal distribution follows a specific mathematical rule known as the empirical rule or the 68-95-99.7 rule. This rule states that for any normally distributed dataset, approximately sixty-eight percent of the values will fall within one standard deviation of the mean. Furthermore, approximately ninety-five percent of the data points will lie within two standard deviations. Finally, almost all observations, or ninety-nine point seven percent, are expected to fall within three standard deviations from the center of the distribution.

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165. (C) Mean
Statistical moments are values that describe the shape and location of a distribution. These moments can be calculated either about the mean or about the origin. The first raw moment, which is the first moment calculated about the origin, is mathematically identical to the arithmetic mean of the dataset. It provides a measure of the central location of the data. Higher moments about the origin are used in more complex calculations, but the first is the most fundamental measure of center.

166. (B) Chi-square test for independence
When a researcher wants to investigate whether there is an association between two categorical variables, such as gender and passing or failing an exam, the Chi-square test for independence is the appropriate statistical tool. This non-parametric test compares the observed frequencies in a contingency table with the frequencies that would be expected if the two variables were completely unrelated. If the difference is significant, the researcher concludes that gender and exam success are likely associated with each other.

167. (D) To confirm that the model's predictions are accurate for data it has not seen before.

mathematical property of this distribution is that its mean is exactly equal to its variance. This parameter, often denoted by the Greek letter lambda, represents the average rate of occurrence. This equality makes the Poisson distribution particularly useful for analyzing datasets where the variance increases proportionally with the mean.

122. (A) Sample
In statistics, a population refers to the entire group of individuals that a researcher wants to study, which in this case is all 500 villagers. A sample is a smaller subset of that population that is actually measured or surveyed to provide data for analysis. Here, the 50 people selected from the village constitute the sample. Researchers use samples because it is often impractical or impossible to collect data from every single individual in a large population.

123. (D) χ^2-distribution
The Chi-square distribution is a probability distribution used in various statistical tests of significance. One of its most common applications is the goodness of fit test. This test evaluates whether a set of observed sample frequencies matches a specific theoretical distribution, such as the normal or Poisson distribution. By calculating the sum of squared differences between observed and expected frequencies, researchers can determine if the data fits the expected model using the Chi-square statistic and its associated distribution.

124. (A) Both A and R are true and R is the correct explanation of A.
The median is considered a robust measure of central tendency because its value is determined only by the relative order of the data points, not their specific magnitudes. If a dataset contains extreme outliers, the arithmetic mean can be shifted significantly toward those values, potentially giving a misleading impression of the center. In contrast, the median remains at the middle position, effectively ignoring the extreme values. This makes the median more reliable for describing the center of skewed distributions.

125. (C) Forecasting
Once a regression model has been developed and validated, its primary application is to predict the value of a dependent variable based on new or future values of the independent variables. This process is known as forecasting. It allows researchers to estimate outcomes in situations where they have not yet observed the dependent variable, provided the independent variables are known. Forecasting is a vital tool for planning, risk assessment, and decision-making in many scientific and environmental fields.

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126. (D) Discrete and ratio scale
The number of asthma cases is determined by counting individual people, which means it can only take on whole, separate values, making it a discrete variable. Furthermore, the data is measured on a ratio scale because it has a true zero point, representing the complete absence of cases. Equal intervals exist between the counts, and it is mathematically meaningful to say that one week had twice as many cases as another, satisfying the requirements of a ratio measurement.

127. (A) The probability of two independent events occurring together is the sum of their individual probabilities.
Basic probability theory includes several fundamental rules. Probabilities always range between zero and one, the sum of all possible outcomes is exactly one, and the probability of an event and its complement must sum to one. However, the rule for independent events is multiplicative, not additive. The probability of two independent events occurring simultaneously is the product of their individual probabilities. Adding probabilities is only appropriate when calculating the likelihood of either one of two mutually exclusive events occurring.

128. (A) I, II, III, and V
The Leslie matrix model is a discrete-time population model with several key features. Its first row contains fecundity rates, while the sub-diagonal contains survival probabilities for each age class. All other elements are typically zero. The model is also built on the assumptions of a constant environment and density-independent growth. However, the matrix is multiplied by an age-distribution vector representing the number of individuals in each age class, rather than just a single value for total population size.

built and calibrated using a training dataset, its predictive power must be tested on a separate, independent dataset that the model has not previously encountered. This process helps researchers determine if the model is generalizable to new situations or if it has simply been over fitted to the original data. A well-validated model provides greater confidence for future forecasting and scientific applications.

145. (A) Both A and R are true and R is the correct explanation of A.
The t-distribution is used instead of the normal distribution when the population variance is unknown and must be estimated from a sample. This distribution has heavier tails to account for the extra uncertainty in small samples. As the sample size increases, the sample standard deviation becomes an increasingly precise estimate of the population standard deviation. Consequently, the uncertainty decreases, and the t-distribution gradually changes shape until it is nearly identical to the standard normal distribution for large sample sizes.

146. (A) Predicting a student's exam score based on the number of hours they studied.
Simple linear regression is designed to model the straight-line relationship between one continuous dependent variable and exactly one continuous independent variable. In this case, predicting an exam score from the number of study hours fits this criteria perfectly. The other scenarios are not appropriate for simple regression: comparing three groups requires ANOVA, analyzing multiple predictors requires multiple regression, and looking for an association between categorical variables like gender and passing requires a Chi-square test or logistic regression.

147. (C) It is positively skewed.
The standard normal distribution is a specific type of continuous probability distribution with several defining characteristics. It has a mean of exactly zero and a standard deviation of one. Its shape is perfectly symmetric and bell-shaped, which means it has a skewness of zero and is not skewed in either direction. Additionally, like all probability distributions, the total area under the curve is exactly one. Therefore, the claim that it is positively skewed is incorrect.

148. (D) Ordinal
Measurement on an ordinal scale allows researchers to rank or order data points based on a specific attribute. For example, ranking candidates as first, second, or third provides information about their relative standing. However, the difference or distance between the first and second rank is not necessarily the same as the difference between the second and third. Because this scale provides order but lacks consistent, equal intervals between the measured categories, it is classified as an ordinal scale.

149. (C) Two main effects and one interaction effect.
Two-way Analysis of Variance is used to study the effects of two categorical independent variables on a single continuous dependent variable. This statistical procedure allows for the testing of three distinct hypotheses. First, it evaluates the two main effects, which represent the individual impact of each factor on the outcome. Second, it tests for a significant interaction effect, which determines if the influence of one independent variable changes depending on the level of the other factor being studied.

150. (B) The rate at which prey are consumed by predators.
In the classic Lotka-Volterra predator-prey model, population changes are described using differential equations. The interaction between the two species is often represented by a term that involves the product of both population sizes. In the equation for prey population growth, this negative term signifies the rate of predation. The coefficient represents the probability of a successful capture during an encounter. This term is fundamental because it links the survival of the prey directly to the abundance of the predator population.

151. (D) -0.5
Probability is a mathematical measure of the likelihood that a specific event will occur. According to the axioms of probability theory, every probability value must fall within the inclusive range of zero to one. A value of zero indicates that the event is impossible, while a value of one indicates certainty. Mathematical probabilities cannot be negative, nor can they exceed one. Therefore, a value of negative

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every single data point in the set into its calculation. While statement one is incorrect because the range is less stable, statement two accurately identifies that standard deviation uses all the values in its mathematical formula.

137. (C) It can be used to establish definitive causality.
Linear regression is a robust statistical tool used to model and predict the relationship between a dependent variable and one or more independent variables. It typically utilizes the method of least squares to find the line that best fits the data. However, a significant regression result only demonstrates an association or correlation between the variables. It does not provide definitive evidence of causality. Proving that one variable causes another requires careful experimental control and a logical theoretical explanation beyond statistical modeling.

138. (A) (r - 1) * (c - 1)
For a Chi-square test of independence using a contingency table, the degrees of freedom are determined by the number of independent categories in the rows and columns. This is calculated by taking the number of rows minus one and multiplying it by the number of columns minus one. This calculation accounts for the fact that if you know the marginal totals, some of the cell counts are automatically determined, leaving only a specific number of values free to vary independently.

139. (D) Validating the model against an independent data set.
Developing a reliable environmental model requires more than just fitting it to existing data. A critical step in the process is validation, where the model's accuracy is tested using a new, independent dataset that was not involved in the calibration or training phase. This ensures the model has true predictive power and is not just overfit to a specific set of observations. Successful validation provides scientific confidence that the model can be used for forecasting and decision-making.

140. (B) A strong positive association, likely due to a confounding variable like temperature.
A high correlation coefficient of zero point eight five indicates a very strong positive relationship between ice cream sales and drowning. However, this does not mean that one causes the other. In many cases, such correlations are spurious and are caused by a third variable, such as warm weather. As temperature increases, more people both eat ice cream and go swimming, leading to a rise in both statistics. This example highlights why correlation should never be confused with causation.

141. (B) II and III only
Understanding the classification of statistical measures is essential for accurate data interpretation. A ratio scale is characterized by a true zero point, which allows for the comparison of magnitudes through ratios. Standard error is used to measure the variability of a sample statistic, providing information about its precision. However, the mean, median, and mode are measures of central tendency, not dispersion. Additionally, a leptokurtic distribution is more peaked than a normal distribution, making the first and fourth statements incorrect.

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142. (D) Poisson
The Poisson distribution is the most appropriate model for analyzing the number of times a specific event occurs within a fixed, continuous interval such as time or space. It is widely used for modeling arrival processes, such as the frequency of telephone calls at a center, the number of radioactive decays per second, or the number of mutations in a DNA segment. This distribution is effective when events occur independently and at a constant average rate over the given interval.

143. (A) Bimodal
In statistics, the mode is the value that appears most frequently in a dataset. While many distributions have a single peak, or are unimodal, it is possible for a dataset to have more than one value with the highest frequency. If there are exactly two distinct values that occur more often than any others and with the same frequency, the distribution is described as bimodal. This often suggests that the sample might be drawn from two different sub-populations with different characteristics.

144. (B) Assessing the performance of a fitted model on a new, independent dataset.
Validation is a crucial final step in the regression modeling process. Once a model has been

of committing a Type I error, which is the act of incorrectly rejecting a null hypothesis that is actually true. By setting alpha at a specific value, like zero point zero five, the researcher is willing to accept a five percent risk of making such a false positive conclusion.

99. (C) $Y = a + bX$
A linear model is a mathematical expression that represents the relationship between a dependent variable and one or more independent variables as a straight line. The hallmark of a simple linear model is that each variable is raised to the first power and is not part of a more complex function like an exponent or a square. This simplicity allows researchers to easily interpret the constant rate of change between the variables and make straightforward predictions within the data range.

100. (D) One-way ANOVA
One-way Analysis of Variance is the appropriate statistical procedure when the goal is to compare the means of a continuous dependent variable across three or more independent groups. In this irrigation study, the yield is the continuous outcome, and the three irrigation methods represent the categorical factor with three levels. ANOVA determines if at least one of these methods results in a significantly different average yield compared to the others, rather than performing multiple individual t-tests.

101. (B) II, I, IV, III, V
Hypothesis testing follows a specific logical sequence to ensure the validity of scientific conclusions. First, the researcher must clearly state the null and alternative hypotheses. After the hypotheses are defined, sample data is collected through observation or experimentation. This data is then used to calculate the appropriate test statistic. This statistic is compared to a critical value or used to find a p-value. Finally, based on this comparison, the researcher decides to reject or fail to reject the null hypothesis.

102. (B) No linear relationship between the variables
The Pearson correlation coefficient quantifies the linear association between two variables. A value of zero specifically indicates that there is no straight-line relationship between them. This means that knowing the value of one variable provides no information about the predicted value of the other variable using a linear model. However, it is important to note that a zero correlation does not necessarily mean the variables are completely unrelated; they could still have a strong non-linear or curvilinear relationship.

103. (D) The tendency of a sampling method to systematically over- or under-estimate a population parameter.
In statistics, bias refers to a systematic error in the sampling process that leads to results that are consistently different from the true population value. This is distinct from random sampling error, which occurs due to natural variation. Bias can arise from a flawed sampling frame, non-response from certain groups, or biased measurement tools. A biased sampling method produces an estimate that is persistently higher or lower than the actual parameter, regardless of how large the sample size becomes.

104. (A) I, II, and IV
Environmental modeling involves creating simplified representations of complex natural systems. A linear model assumes that the relationship between variables follows a straight line. Validation is an essential step that ensures the model is accurate and useful for its intended purpose by testing it against independent data. However, forecasting involves predicting future events, not past ones, and multiple regression models are defined by having more than one independent variable, while they typically still focus on a single dependent variable.

105. (A) Both Statement I and Statement II are correct.
The F-distribution is a continuous probability distribution used extensively in ANOVA and regression analysis. It is characterized as a family of distributions where the specific shape is determined by two separate degrees of freedom, one for the numerator and one for the denominator. Additionally, because the F-statistic is calculated as a ratio of two variances, and variances are squared quantities that cannot be negative, the resulting F-value is always non-negative. Both statements correctly describe these fundamental properties.

106. (A) Age-specific fecundity rates

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zero point five is not a valid probability in any statistical context.

152. (C) Statement I is correct but Statement II is incorrect.
The coefficient of variation is a useful statistical tool for comparing the relative variability of different datasets, especially when they have different units or means. It is unitless because it is a percentage or ratio. While statement one correctly identifies it as a relative measure, statement two contains an error. The coefficient of variation is actually calculated by dividing the standard deviation by the mean, not the other way around. This ratio expresses the dispersion relative to the central value.

153. (C) A vector representing the number of individuals in each age class at the next time step
Leslie's matrix model is used for population projection by performing matrix multiplication. When the Leslie matrix, which contains age-specific survival and fecundity rates, is multiplied by a vector representing the current number of individuals in each age class, the result is a new vector. This output vector provides the predicted number of individuals that will be in each age class during the very next time interval. This process allows ecologists to track changes in population structure over time.

154. (A) A stronger level of evidence is required to reject the null hypothesis.
The significance level, denoted as alpha, represents the threshold for rejecting the null hypothesis. By reducing this value from zero point zero five to zero point zero one, the researcher is setting a stricter criterion for what counts as statistically significant. This means that the observed data must be even more extreme and unlikely to have occurred by chance before the null hypothesis is rejected. While this reduces the risk of a Type I error, it makes rejection more difficult.

155. (D) Mann-Whitney U test
The independent samples t-test is a parametric test that assumes data are normally distributed. When these assumptions are violated, such as with skewed data or ordinal measurements, a non-parametric alternative must be used. The Mann-Whitney U test is the non-parametric equivalent for comparing two independent groups. Instead of comparing means, it compares the ranks of the observations. This test is more robust and appropriate for data that do not meet the strict requirements of the standard t-test.

156. (B) II, III, and V
Regression models have several key properties and assumptions. Multiple regression allows for the simultaneous assessment of multiple predictors, and the intercept represents the predicted outcome when all predictors are zero. Additionally, a well-fitting model should have residuals that are randomly distributed around zero, showing no patterns. However, statement one is false because linear models are not always the best fit, and statement four is false because validation must be performed using a new, independent dataset to be valid.

157. (C) Fail to reject the null hypothesis as there is no strong evidence against it
In statistical hypothesis testing, the p-value is compared to the significance level to make a decision. A very high p-value, such as zero point eight five, indicates that the observed data is very likely to occur if the null hypothesis is true. Since this value is much larger than common significance levels like zero point zero five, the researcher has no reason to doubt the null hypothesis. Therefore, the correct conclusion is to fail to reject the null hypothesis.

158. (D) The accuracy of the sample mean as an estimate of the population mean.
The standard error of the mean is a critical statistic that quantifies the amount of variation expected between different sample means drawn from the same population. It is calculated by dividing the sample standard deviation by the square root of the sample size. A smaller standard error indicates that the sample mean is likely to be very close to the actual population mean, thereby serving as a measure of the precision and accuracy of the statistical estimate.

159. (B) P-3, Q-4, R-1, S-2
Statistical tests use specific test statistics that follow known probability distributions. The z-score is associated with the standard normal distribution, while the t-score follows the t-distribution, which is used for smaller samples.

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not allow for the generalization of results to the entire population.

114. (A) 3.5 units
In a simple linear regression equation, the coefficient associated with the independent variable is known as the slope. This value represents the expected change in the dependent variable for every single unit of increase in the independent variable. In the provided equation for tree growth, the slope is three point five. Therefore, for every one-unit increase in the trunk diameter, the model predicts that the height of the tree will increase by exactly three point five units.

115. (C) Nominal
Measurement scales determine the level of mathematical operations that can be performed on data. The brand of a car is a categorical variable that serves only to identify or label different groups. There is no inherent numerical value or logical order associated with these names. Because the categories are purely descriptive and cannot be ranked or measured for differences in magnitude, they represent a nominal scale. This is the simplest level of measurement used in statistical classification.

116. (D) The species grow logistically, unaffected by each other.
The Lotka-Volterra competition model describes how two species influence each other's population growth. The competition coefficients in these equations represent the negative impact that one species has on the other. If these coefficients are set to zero, it mathematically implies that neither species is affected by the presence or density of the other. Consequently, each population will follow its own independent logistic growth pattern, eventually reaching its specific carrying capacity as determined by available environmental resources.

117. (C) Rejecting H_0 when H_0 is false.
The power of a statistical test is a measure of its sensitivity and ability to detect an effect when one truly exists. It is mathematically defined as the probability of correctly rejecting a null hypothesis that is indeed false. A high-power test reduces the risk of committing a Type II error, which is the failure to detect a significant difference. Researchers aim for higher power by increasing sample sizes or improving experimental design to ensure reliable scientific conclusions.

118. (B) As the degrees of freedom decrease, it becomes more like the standard normal distribution.
The t-distribution is a symmetric distribution used when estimating the mean from small samples with an unknown population variance. While it is bell-shaped like the normal distribution, it has thicker tails to account for greater uncertainty. A critical property is that as the degrees of freedom increase, which corresponds to larger sample sizes, the t-distribution becomes more like the standard normal distribution. Therefore, the statement claiming it becomes more like the normal distribution as degrees of freedom decrease is incorrect.

119. (D) Independent samples t-test
An independent samples t-test is the most appropriate statistical method for comparing the means of a continuous variable from two separate and unrelated groups. In this scenario, the two fish populations in different lakes are independent because the measurements in one group do not influence or relate to the measurements in the other. The test will determine if the observed difference in average body weight between the two lakes is statistically significant or simply due to random variation.

120. (A) Both Statement I and Statement II are correct.
Regression analysis is a versatile statistical tool used to model the relationship between variables. Simple linear regression is defined by having exactly one dependent variable and one independent variable, representing a straight-line relationship. Multiple regression expands this by including two or more independent variables to explain the variation in a single dependent variable. Both statements accurately define these common types of regression models, which are essential for understanding complex relationships where multiple factors influence an outcome.

121. (C) The mean is equal to the variance.
The Poisson distribution is a discrete probability distribution used to model the number of independent events occurring within a fixed interval of time or space. A unique and defining

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Model validation is a critical step in the development of environmental models. Its primary goal is to assess the predictive performance and generalizability of a model by testing it against a new, independent dataset. This dataset must not have been used during the calibration or fitting process. A successful validation confirms that the model can accurately predict outcomes in new situations, providing researchers with the confidence needed to use the model for real-world applications and future forecasting.

168. (A) I and IV only
Statistical tests are categorized by their specific functions and the type of data they analyze. A t-test is correctly used to compare the means of two groups. Regression analysis is used to model the relationship between dependent and independent variables. However, ANOVA is primarily used to compare means across multiple groups, not variances. Additionally, the Chi-square test is specifically designed for categorical data, not continuous data. Therefore, only the first and fourth statements provided in the list are correct.

169. (C) A set of coupled non-linear differential equations
The Lotka-Volterra predator-prey model is a classic mathematical representation of biological interactions between two species. It consists of two first-order, non-linear differential equations that are coupled because the rate of change in each population depends on the current size of both populations. These equations describe how the populations of predators and prey fluctuate over time. The non-linear nature of the interaction term leads to the characteristic cyclical oscillations often observed in the resulting population trajectories.

170. (A) 0
Skewness is a measure of the asymmetry of a probability distribution. In a perfectly symmetric distribution, such as the normal distribution, the data on the left side of the mean is a mirror image of the data on the right side. Because there is no imbalance or longer tail in either direction, the mathematical calculation for skewness results in a value of exactly zero. This benchmark allows statisticians to quantify how far other, asymmetrical distributions depart from perfect symmetry.

171. (D) The number of independent pieces of information available to estimate a parameter.
In statistics, degrees of freedom represent the number of values in a final calculation that are free to vary independently. When estimating a parameter like the mean from a sample, the sum of the deviations must always equal zero. This constraint means that once most of the data points are known, the final one is fixed. Consequently, for a sample of size n, there are n minus one degrees of freedom. This value is critical for determining the correct probability distribution.

172. (D) Statement I is incorrect but Statement II is correct.
Sampling theory involves understanding how samples represent populations. Statement one is incorrect because even a simple random sample can be unrepresentative due to random chance, especially if the sample size is small. However, statement two correctly defines sampling error as the natural, expected difference between a sample statistic, like the mean, and the actual population parameter. This error is an inherent part of the sampling process and decreases as the size of the sample is increased.

173. (C) The overall significance of the entire regression model
In multiple regression analysis, the F-test is used to evaluate the collective importance of all the independent variables included in the model. It tests the null hypothesis that all the regression coefficients are equal to zero, meaning none of the independent variables explain the variance in the outcome. A significant F-test result indicates that the regression model as a whole provides a better fit for the data than a model with no predictors, suggesting a statistically meaningful relationship exists.

174. (D) Weight of a soil sample.
Continuous variables are quantitative characteristics that can take on any numerical value within a given range, including fractions and decimals. The weight of a soil sample is a classic example because it can be measured with increasing levels of precision depending on the

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specific impact of each independent variable on the dependent variable. The coefficient b1 quantifies the expected change in the dependent variable for every single unit increase in the first independent variable, under the condition that all other independent variables in the model are kept constant. This allows researchers to isolate the unique contribution of each predictor while controlling for the potential influence of other factors.

190. (D) Leslie's matrix model
Leslie's matrix model is specifically designed to account for the age structure of a population. Unlike simpler models like the logistic growth model, which treat all individuals as identical, the Leslie model divides the population into distinct age classes. It uses age-specific survival and fecundity rates to project how both the total population size and its internal age distribution will change over time. This makes it an essential tool for studying the population dynamics of long-lived species with complex life cycles.

191. (A) Standard Deviation
Measures of central tendency, such as the mean, median, and mode, are used to identify the central location or typical value within a dataset. In contrast, measures of dispersion are used to describe the spread or variability of the data points. Standard deviation is a measure of dispersion that quantifies the average amount by which individual values differ from the arithmetic mean. Therefore, standard deviation provides information about the spread of data rather than its central tendency.

192. (B) Population
In statistics, it is crucial to distinguish between characteristics of samples and characteristics of the entire group. A population represents the complete set of individuals or objects that a researcher is interested in studying. Any numerical value that summarizes a characteristic of this entire population—such as the true population mean or standard deviation—is called a parameter. Parameters are typically unknown and must be estimated using statistics calculated from smaller, representative samples drawn from that specific population.

193. (B) 1
Probability is measured on a scale from zero to one. A probability of zero indicates that an event is impossible and will never occur. At the other end of the scale, a probability of exactly one indicates that an event is certain to happen. This represents a one hundred percent likelihood of occurrence. Any event that is guaranteed by the conditions of the experiment to take place must have a probability of one, according to the fundamental rules of probability theory.

194. (A) There is a highly significant difference between at least two of the group means
In Analysis of Variance, the p-value associated with the F-test indicates the probability of observing the data if the null hypothesis were true. The null hypothesis in ANOVA states that all group means are equal. A very small p-value, such as zero point zero zero one, is much less than the standard significance level of zero point zero five. This provides strong evidence to reject the null hypothesis, leading to the conclusion that at least one group mean is significantly different.

195. (B) I, II, and III only
Measures of shape provide detailed information about a distribution. Skewness describes its degree of symmetry, while kurtosis describes its peakedness relative to a normal distribution. A perfectly symmetric normal distribution has a skewness value of exactly zero. However, the fourth statement is incorrect because a normal distribution has a kurtosis value of three. In many cases, excess kurtosis is used, where the value for a normal distribution is zero, but the absolute kurtosis remains three for a bell curve.

196. (D) Sample
Statisticians use specific terminology to describe numerical summaries of data. A population is the entire group of interest, and its numerical characteristics are called parameters. A sample is a smaller subset of individuals selected from that population for measurement. Any numerical characteristic that is calculated from this sample data—such as the sample mean or sample variance—is called a statistic. Statistics are used to make inferences about the unknown parameters of the larger population from which they were drawn.

197. (C) Height of a person in centimeters.

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182. (B) Its shape is determined by a single parameter, the degrees of freedom
The Chi-square distribution is a continuous probability distribution used extensively in hypothesis testing. Unlike the normal distribution, which is defined by its mean and standard deviation, the shape of the Chi-square distribution depends entirely on a single parameter: the degrees of freedom. For small degrees of freedom, the distribution is highly positively skewed. As the degrees of freedom increase, the distribution changes shape, gradually becoming more symmetric and eventually approximating a normal distribution for very large values.

183. (D) Ordinal
When data is ranked, such as a student's position in a class, it is measured on an ordinal scale. This scale provides a clear hierarchy or order, where a first-place rank is higher than a second-place rank. However, the ordinal scale does not provide information about the exact numerical distance between the ranks. For instance, the difference in scores between the first and second student might be very different from the difference between the second and third students.

184. (A) I, II, and IV
Lotka-Volterra models are foundational ecological models expressed as pairs of coupled differential equations. The competition model can successfully predict whether species will coexist or if one will be excluded. The predator-prey model assumes that predators have an unlimited appetite and can consume prey in direct proportion to their encounter rate. However, these basic models are deterministic, not stochastic, and the standard predator-prey version does not include a carrying capacity for either the prey or the predator population.

185. (C) There is a calculation error, as the correlation coefficient cannot be greater than 1
The Pearson correlation coefficient is a standardized measure of the linear relationship between two variables. By mathematical definition, its value must always fall within the inclusive range of negative one to positive one. A value of positive one indicates a perfect positive linear relationship, while negative one indicates a perfect negative relationship. Because a correlation coefficient cannot exceed these boundaries, a calculated value of one point two five is mathematically impossible and indicates a fundamental error in calculation.

186. (A) The data within each group are approximately normally distributed.
One-way Analysis of Variance is a parametric statistical test that relies on several key assumptions to provide valid results. One of the most important requirements is that the dependent variable follows a normal distribution within each of the groups being compared. Other assumptions include the independence of observations and the equality of variances among the different groups. If these conditions are not met, the results of the ANOVA may be unreliable, and non-parametric alternatives should be considered.

187. (D) Sample size
In statistics, the total number of individual observations or data points collected during a study is known as the sample size, often denoted by the letter n. The sample size is a critical factor because it directly influences the reliability and precision of the statistical estimates. Larger sample sizes generally lead to smaller standard errors and more narrow confidence intervals, providing researchers with greater confidence that the sample statistics are an accurate representation of the true population parameters.

188. (B) Both Statement I and Statement II are incorrect.
Probability distributions are classified as either discrete or continuous based on the type of variables they model. The Binomial distribution is a discrete distribution because it models the number of successes in a fixed number of trials, which must be whole integers. Conversely, the normal distribution is a continuous distribution because it models variables that can take any value within a range. Both statements provided are incorrect because they have swapped the classifications for these two fundamental probability distributions.

189. (C) The change in Y for a one-unit change in X_1, holding X_2 constant.
In a multiple linear regression model, the partial regression coefficients represent the

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220. (C) Statement I is correct but Statement II is incorrect.
Regression analysis is used to find the line that provides the best fit for a set of data points on a scatter plot. Statement one is correct in identifying this goal. However, statement two contains an error in the definition of the best fit. The standard method for determining the regression line is called ordinary least squares, which involves minimizing the sum of the squared residuals, not maximizing them. This minimization ensures that the line is as close as possible to the data points.

221. (B) P-2, Q-4, R-1, S-3
Statistical measures are classified according to their analytical purpose. The mean provides a measure of central location, while the standard deviation serves as a measure of absolute dispersion. The coefficient of variation is used to compare dispersion relative to the mean, especially across different datasets. Finally, skewness is specifically designed to measure the degree of asymmetry in a distribution. Correctly matching these measures to their purposes is essential for fully describing and comparing the characteristics of any statistical dataset.

222. (D) Using a model to predict future states or values.
Forecasting is a critical application of environmental and statistical modeling. It involves using a validated mathematical or biological model to project the future behavior of a system based on current or hypothetical conditions. For example, researchers might use a regression model to forecast future pollution levels or a Leslie matrix to project the future size of an endangered species. Forecasting provides essential information for proactive planning, resource management, and the development of strategies to mitigate potential future environmental risks.

223. (A) There is a perfect negative linear relationship between the variables.
The Pearson correlation coefficient measures the strength and direction of the linear association between two variables. A value of negative one is the lowest possible score and represents a perfect negative linear relationship. This means that every single data point falls exactly on a downward-sloping straight line. In such a scenario, for every unit of increase in one variable, there is a consistent and predictable decrease in the other variable, showing that the two variables are perfectly and inversely related.

224. (B) The independent variable must be normally distributed.
Simple linear regression relies on several key assumptions to ensure that the statistical results and predictions are valid. These assumptions include the existence of a linear relationship between the variables, the normal distribution of the residuals, and constant variance of those residuals. However, it is a common misconception that the independent variable must also be normally distributed. In reality, regression only requires the error terms or residuals to be normal; the independent variable can follow any type of distribution.

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225. (B) Can analyze the effect of two independent variables simultaneously.
The primary distinction between one-way and two-way Analysis of Variance lies in the complexity of the research design. While one-way ANOVA evaluates the influence of a single categorical independent variable on a continuous outcome, two-way ANOVA allows researchers to assess two factors at the same time. This expanded analysis provides information on the individual effect of each factor and, crucially, allows for the investigation of an interaction effect, where the factors may combine to influence the outcome in unique ways.

226. (D) I, II, and III only
Probability distributions have distinct characteristics used for different types of data. The normal distribution is symmetric and bell-shaped. The Poisson distribution is the standard model for count data. The Binomial distribution models the number of successes in a fixed number of trials. However, the fourth statement is incorrect because the t-distribution is specifically used when the population variance is unknown. If the population variance were known, researchers would use the standard normal distribution for their hypothesis testing and calculations.

227. (C) Defining the model's objectives and scope.

The ratio scale of measurement is the most informative scale because it includes a true zero point, representing the complete absence of the characteristic being measured. Height in centimeters is a ratio scale measurement because zero centimeters truly means no height, and it is mathematically valid to say that a person who is two hundred centimeters tall is exactly twice as tall as someone who is one hundred centimeters. Celsius temperature and calendar years lack this absolute zero property.

198. (B) Can ensure representation from different subgroups of the population.
Stratified random sampling involves dividing a heterogeneous population into smaller, more homogeneous subgroups called strata based on specific characteristics, such as age or location. A separate random sample is then drawn from each stratum. This method is advantageous because it ensures that all important subgroups are adequately represented in the final sample. This representation improves the precision of estimates for both the entire population and the individual subgroups, making the study results more comprehensive and accurate.

199. (A) Both A and R are true and R is the correct explanation of A.
A deterministic model is one in which the future state of the system is entirely determined by its initial conditions and parameters, with no involvement of random chance. The classic Lotka-Volterra equations are deterministic because they use a set of fixed differential equations that will always yield the exact same population trajectories for the same starting values. They do not account for stochastic factors, such as random weather events or individual variations, that would introduce unpredictability into real-world population dynamics.

200. (A) Standard deviation is the square root of the variance.
Variance and standard deviation are both measures of dispersion that describe the spread of values in a dataset. Variance is calculated as the average of the squared differences from the mean, which results in units that are squared relative to the original measurements. To bring the measure of spread back to the same units as the original data, the square root of the variance is taken. This resulting value is known as the standard deviation, the most common measure of variability.

201. (A) P-2, Q-4, R-1, S-3
Choosing the correct statistical test depends on the research question and the type of data collected. Linear regression models the relationship between two continuous variables like rainfall and yield. One-way ANOVA compares means across multiple categorical groups, such as different fertilizers. A paired t-test is used for dependent measurements like pH before and after an event. Finally, the Chi-square test is appropriate for assessing associations between categorical variables like soil type and the presence of a specific plant species.

202. (A) F-ails to reject a false null hypothesis.
In hypothesis testing, a Type II error occurs when the researcher fails to find a statistically significant result despite the fact that a real effect or difference exists in the population. This is also known as a false negative. The probability of committing this error is denoted by the Greek letter beta. Type II errors often happen when the sample size is too small or the variability in the data is too high to detect the true difference.

203. (D) Symmetric
A symmetric distribution is one where the data points are distributed evenly around a central value, such as the mean. If the distribution were folded in half at this center point, the two sides would overlap perfectly, as one side is a mirror image of the other. The normal distribution is the most famous example of a symmetric distribution. In such cases, the skewness is zero, and the mean, median, and mode all coincide at the exact same central location.

204. (B) III, IV, I, II
Using a Leslie matrix to project population changes follows a logical mathematical sequence. First, the Leslie matrix itself must be constructed using known age-specific fecundity and survival rates. Next, the researcher must determine the initial age distribution vector, representing the number of individuals currently in each age class. Then, the matrix is multiplied by this initial vector. The final output of this multiplication is the new vector representing the predicted

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tool used. In contrast, the other examples listed—the number of leaves, cars, or eggs—are all discrete variables because they involve counting individual units and can only result in whole integer values.

175. (A) 1
One of the fundamental axioms of probability theory states that the sum of the probabilities of all possible, mutually exclusive outcomes in a sample space must equal exactly one. This ensures that the total likelihood of any event occurring within the experiment is fully accounted for. For example, when flipping a coin, the probability of heads and the probability of tails together sum to one. This property is essential for the valid construction of all probability distributions and statistical models.

176. (B) The interval becomes wider.
The confidence level represents the degree of certainty that a confidence interval contains the true population parameter. To increase this level of certainty from ninety-five percent to ninety-nine percent, the researcher must account for more potential variation in the estimate. This requires a larger margin of error, which corresponds to a higher critical value from the probability distribution. Consequently, the resulting confidence interval becomes wider to ensure that the actual parameter is captured more reliably within its boundaries.

177. (B) Using purely anecdotal evidence without any data
Developing sound environmental models requires a scientific approach based on data, theory, and rigorous testing. Valid methods include using linear regression to find associations, process-based differential equations to model interactions, and matrix models to project population changes. Using purely anecdotal evidence without any supporting data is not a legitimate approach to modeling. Anecdotes lack the representativeness and mathematical structure needed to build reliable models that can be validated, calibrated, and used for accurate scientific forecasting.

178. (A) Leptokurtic (peaked with heavy tails)
Kurtosis measures the shape of a distribution relative to the normal distribution, which has a kurtosis of three. A distribution with a kurtosis value significantly greater than three is called leptokurtic. This type of distribution is characterized by a very sharp, high peak and thick, heavy tails. The presence of heavy tails indicates that extreme values or outliers occur more frequently in this distribution than they would in a perfectly bell-shaped, normal distribution with the same variance.

179. (A) Both A and R are true and R is the correct explanation of A.
Analysis of Variance and the t-test are closely related statistical methods used to compare group means. While the t-test is restricted to comparing exactly two groups, ANOVA is a more general tool that can handle any number of groups. When ANOVA is applied to a situation with only two groups, the calculated F-statistic is exactly equal to the square of the t-statistic. Therefore, ANOVA is considered a logical extension of the t-test that provides equivalent results for two-group comparisons.

180. (D) Model the linear relationship between two continuous variables.
Simple linear regression is a powerful statistical technique used to describe and analyze the straight-line relationship between a single continuous independent variable and a single continuous dependent variable. By fitting a regression line to the observed data, researchers can determine the intercept and the slope of the relationship. This model allows for both the quantification of the association between the variables and the prediction of the dependent variable for any given value of the independent variable.

181. (A) P-2, Q-1, R-3, S-4
Different statistical measures serve unique purposes in data analysis. Skewness describes the degree of asymmetry, while kurtosis quantifies the peakedness of a distribution. The standard error is specifically the standard deviation of a sampling distribution, representing the precision of a sample statistic. Variance provides a measure of absolute dispersion by calculating the average of squared deviations from the mean. Correctly matching these concepts is essential for understanding both the central location and the shape of a dataset.

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it provides more food for predators, leading to a delayed increase in the predator population. This higher predation eventually causes the prey population to crash, which in turn leads to a decline in predators due to starvation. This cycle repeats indefinitely in the basic model, representing the dynamic balance between the two species.

213. (C) the mean is 0 and the standard deviation is 1
The standard normal distribution is a unique and standardized form of the normal distribution. It is characterized by having an arithmetic mean of exactly zero and a standard deviation of exactly one. This standardization allows statisticians to use z-scores to compare values from different normal distributions on a single common scale. By transforming any normal distribution into the standard normal form, researchers can easily determine probabilities and percentiles using standardized tables or software for any set of continuous data.

214. (B) The relationship observed in the sample is likely to exist in the population.
When a regression model is statistically significant, it means that the relationship between the independent and dependent variables is unlikely to have occurred by random chance. In other words, there is strong evidence that a similar association exists in the larger population from which the sample was drawn. However, statistical significance does not imply that the model is perfect or that the relationship is causal. It only provides confidence that the observed association is real and not a sampling fluke.

215. (D) The country of origin for an imported product
The nominal scale is the simplest level of measurement, used for variables that are categorized into distinct groups without any numerical value or inherent order. The country of origin is a perfect example of a nominal variable because it serves only as a label. While countries can be categorized, they cannot be ranked in a way that is mathematically meaningful for calculation. This differs from wind speed or coordinates, which provide more quantitative information or can be placed in order.

216. (A) The significance level α is the probability of a Type I error.
In hypothesis testing, the significance level, alpha, is a fundamental concept that represents the probability of committing a Type I error. This error occurs when a researcher incorrectly rejects a null hypothesis that is actually true, leading to a false positive conclusion. By setting the alpha level before the study begins, the researcher defines the maximum risk they are willing to take of making such a mistake, which is typically set at five percent in most scientific research.

217. (C) The number of offspring produced by an individual of age class j
A Leslie matrix is used for age-structured population projections. The horizontal first row of the matrix is dedicated to fecundity rates for each age group. Specifically, the element located in the first row and column j represents the average number of offspring that an individual in age class j will contribute to the population during a single time interval. These values are essential for determining the number of new individuals that will enter the first age class in the next generation.

218. (A) λ
The Poisson distribution is a discrete probability distribution defined by a single parameter, often represented by the Greek letter lambda. This parameter represents the average rate at which independent events occur within a specified interval of time or space. One of the most important and unique properties of the Poisson distribution is that this parameter lambda is exactly equal to both the arithmetic mean and the variance of the distribution. Therefore, for a Poisson distribution, the mean is simply the value of lambda.

219. (D) One-way ANOVA
One-way Analysis of Variance is the appropriate statistical method for comparing the means of more than two groups. In this study, the concentration of the pesticide is the continuous dependent variable, and the four seasons act as the independent categorical variable with four levels. ANOVA determines if there is a statistically significant difference in the average pesticide concentration across these four groups, helping researchers understand if seasonal changes have a meaningful impact on the water quality levels being monitored.

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number of individuals in each age class for the next time step.

205. (C) y-intercept
In the mathematical equation for a straight line, which is used in simple linear regression, the constant term represented by the letter a is called the y-intercept. This value identifies the point where the regression line crosses the vertical axis. In practical terms, it represents the predicted or expected value of the dependent variable when the independent variable is exactly zero. The y-intercept provides the starting point for the line, while the slope determines its steepness and direction.

206. (B) Both Statement I and Statement II are incorrect.
Measures of central tendency have different strengths and weaknesses. The mean is not always the best measure; for example, it is easily distorted by extreme outliers in skewed distributions. Furthermore, the median is actually robust to individual values because it is based only on the middle position of the data, not on every magnitude. In contrast, it is the arithmetic mean that is sensitive to every single value in the dataset. Both statements provided in the question are therefore statistically incorrect.

207. (A) Binomial
The Binomial distribution is perfectly suited for modeling the outcome of a process consisting of a fixed number of independent trials, where each trial has only two possible results, such as defective or non-defective. In this case, there are ten trials and a constant probability of success—or failure—for each item. This discrete distribution allows researchers to calculate the probability of finding a specific number of defective items within the batch under these well-defined and independent conditions.

208. (B) The color of a flower.
In statistics, characteristics are categorized as either variables or attributes. Variables are quantitative and can be measured or counted numerically, such as weight, length, or concentration. Attributes are qualitative characteristics that describe a quality or trait and cannot be expressed as a natural number. The color of a flower is a classic example of an attribute because it categorizes observations into groups, like red or blue, without assigning a mathematical magnitude to the quality of color itself.

209. (B) Assess the significance of the difference between the means of two groups.
The t-test is a fundamental parametric statistical procedure used to evaluate whether the difference between the means of two groups is statistically significant. It compares the observed difference to the variability within the groups. If the calculated t-statistic is large enough, it suggests that the difference between the groups is unlikely to have occurred by random chance, leading researchers to conclude that the two populations from which the samples were drawn actually have different average values.

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210. (A) I, II, III, and IV
Correlation and regression are related but distinct concepts. Correlation measures the linear strength and direction between variables, while regression provides a mathematical model for prediction. The square of the correlation coefficient, R-squared, indicates the proportion of shared variance. Importantly, a regression model can be fit even if the correlation is zero, although it will have no predictive power. However, a negative correlation does not mean variables are unrelated; it simply means they move in opposite directions, making statement five false.

211. (C) Analysis of Variance
ANOVA is a widely used statistical acronym that stands for Analysis of Variance. This method was developed to compare the means of three or more groups simultaneously by partitioning the total variation in the data into different components. Specifically, it compares the variance between the group means to the variance within the individual groups. This approach allows researchers to determine if the observed differences among group averages are statistically significant or merely the result of random sampling variation.

212. (D) Oscillatory dynamics of predator and prey populations.
A key characteristic of the Lotka-Volterra predator-prey model is its ability to produce continuous, cyclical oscillations in population sizes over time. As the prey population increases,

The initial stage of developing an environmental model is the most critical as it sets the foundation for the entire project. This involves clearly defining the objectives, identifying the specific questions the model aims to answer, and determining its scope or boundaries. By establishing what the model is intended to achieve, researchers can then make informed decisions about the model structure, the necessary data to collect, and the appropriate mathematical techniques for formulation, calibration, and eventual validation.

228. (D) A measure of the average of the squared deviations from the sample mean.
Variance is a fundamental measure of dispersion that quantifies how much the individual values in a dataset vary from their arithmetic mean. It is calculated by taking each data point, subtracting the mean to find the deviation, squaring that deviation to eliminate negative signs, and then averaging those squared values. This process provides a measure of spread that is particularly sensitive to extreme values, with larger variances indicating that the data points are more widely scattered around the center.

229. (C) There is not enough statistical evidence to conclude the alternative hypothesis is true.
In hypothesis testing, a decision to fail to reject the null hypothesis does not mean the null hypothesis has been proven to be true. Instead, it indicates that the observed sample data does not provide sufficiently strong evidence to support the alternative hypothesis at the chosen significance level. The results are considered not statistically significant, meaning the observed patterns or differences could easily have occurred due to random chance rather than being the result of a true population effect.

230. (B) Testing if sample data comes from a population with a specific distribution.
The Chi-square goodness-of-fit test is a non-parametric statistical procedure used to determine if a set of observed sample values follows a hypothesized theoretical distribution, such as the normal, binomial, or Poisson distribution. It works by comparing the actual frequencies observed in the sample categories to the frequencies that would be expected if the data perfectly followed the distribution. This test is essential for verifying whether the assumptions of other, more complex parametric statistical methods are actually met.

231. (A) II, III, I
Statistical models vary in complexity based on the number and type of variables they handle. Simple linear regression is the most basic, involving just one continuous independent variable and one dependent variable. A one-way ANOVA model is slightly more complex as it compares a continuous outcome across several categorical groups. Multiple regression is the most complex among these three because it evaluates the simultaneous impact of two or more independent variables on a single dependent outcome, allowing for a more detailed analysis.

232. (A) Predation
In the classic Lotka-Volterra predator-prey equations, several biological simplifications are used to model the interaction between the two populations. One key assumption is that the prey population has an unlimited food supply and would grow exponentially if left alone. Consequently, the only factor that limits the growth of the prey in this specific model is the rate of predation. The model does not include an environmental carrying capacity, which would normally restrict prey growth in more realistic ecological scenarios.

233. (C) Mode
The mode is a simple yet informative measure of central tendency that identifies the specific value or category that appears most frequently in a given dataset. Unlike the mean and median, which require numeric calculations or ordering, the mode can be applied to both quantitative and qualitative data. A distribution is described as unimodal if it has one most frequent value, and bimodal if it has two. The mode highlights the most common characteristic within the observed population.

234. (B) Both Statement I and Statement II are incorrect.
Measures of dispersion are used to describe the spread of data and have specific mathematical properties. Standard deviation is the square root of variance, and since variance is an average of squared values, it can never be negative. Therefore, standard deviation must also be

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zero or positive. Furthermore, while standard deviation is measured in the same units as the original data, variance is measured in those units squared. Both statements are incorrect because they violate these fundamental definitions and units of measurement.

235. (D) The entire group of individuals or objects that a researcher is interested in.
In a statistical context, the term population refers to the complete and exhaustive set of all possible observations or individuals that share a common set of characteristics and are the focus of a scientific study. This could be all the members of a species in a forest or all the water samples in a lake. Because it is often impossible to measure the entire population, researchers draw smaller, representative samples to estimate the properties of the population.

236. (B) The dependent variable is influenced by more than one independent variable.
Simple linear regression is restricted to modeling the relationship between a single predictor and an outcome. However, in most real-world scenarios, particularly in environmental science, an outcome is influenced by many factors at once. Multiple regression is more appropriate in these cases because it allows researchers to include several independent variables in the same model. This provides a more comprehensive understanding of the data by accounting for the combined and unique contributions of each individual predictor toward explaining the dependent variable.

237. (C) Approximately normal, regardless of the population's distribution.
The Central Limit Theorem is one of the most important concepts in statistics. It states that if you take sufficiently large random samples from any population, the distribution of the sample means will follow a normal distribution, even if the original population distribution is skewed or non-normal. This property is fundamental to inferential statistics because it justifies the use of parametric tests, like the t-test and ANOVA, which rely on the assumption of normality when dealing with large sample sizes.

238. (D) Examine the simple main effects (the effect of one factor at each level of the other factor).
In a two-way Analysis of Variance, a significant interaction effect indicates that the two independent variables do not act independently to influence the outcome. Instead, the effect of one factor changes depending on the level of the other factor. When this happens, reporting the average main effects can be misleading. The correct next step is to conduct an analysis of simple main effects, which investigates how one variable behaves at each specific level of the second variable to understand the interaction.

239. (A) Ratio scales have a true zero point, while interval scales do not.
Interval and ratio scales are both used for quantitative data, but they differ in one key property. A ratio scale possesses a true, absolute zero point, which signifies the complete absence of the characteristic being measured, such as weight or length. In contrast, an interval scale has an arbitrary zero point, such as zero degrees Celsius, which does not mean no heat. Because ratio scales have a true zero, they allow for meaningful ratios, such as saying one value is twice another.

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240. (B) The Chi-square test
The Greek symbol Chi-square, written as a lowercase x with a superscript two, refers specifically to a family of probability distributions used in non-parametric statistical testing. This distribution is the foundation for the Chi-square test, which is used to evaluate the goodness-of-fit of a sample to a theoretical distribution or to test the independence of two categorical variables in a contingency table. It is one of the most widely used statistical tools for analyzing qualitative or frequency-based data.

241. (C) I, II, and III
Statistical tests are designed for specific data types and group comparisons. A t-test is used for comparing means between two groups, and a Chi-square test is appropriate for categorical data. One-way ANOVA compares means across three or more groups. However, statement four is incorrect because two-way ANOVA examines two independent variables, and statement five is incorrect because a paired t-test is used for dependent or matched samples, not independent ones. Therefore, only the first three statements are correct.

242. (A) Mean (μ) and standard deviation (σ)
The normal distribution is a continuous probability distribution whose specific shape and position are entirely determined by two parameters. The arithmetic mean, denoted by the Greek letter mu, identifies the center of the distribution and its peak location. The standard deviation, denoted by the Greek letter sigma, determines the spread or width of the bell curve. Together, these two parameters fully define the normal distribution, allowing statisticians to calculate probabilities for any value within the dataset based on these two measurements.

243. (C) Deterministic and do not include environmental stochasticity or carrying capacity for prey.
The classic Lotka-Volterra equations are valued for their simplicity but have significant limitations when representing real-world ecological systems. They are deterministic, meaning they always produce the same result from the same starting point and ignore random environmental fluctuations. Furthermore, the basic prey equation assumes unlimited resources, lacking a carrying capacity that would normally stabilize growth. This often leads to unstable population oscillations that do not perfectly mirror the complex and unpredictable dynamics observed in actual predator and prey interactions in nature.

244. (D) 0
The coefficient of determination, denoted as R-squared, is calculated in a simple linear regression as the square of the Pearson correlation coefficient. If two variables have a correlation of zero, it means there is no linear relationship between them. Squaring zero results in zero, meaning that zero percent of the variation in the dependent variable is explained by the independent variable. In this case, the regression model has no predictive value and provides no better estimate than simply using the mean.

245. (A) P-3, Q-1, R-4, S-2
Different statistical and mathematical models serve specific research purposes. The Lotka-Volterra model is used to describe biological interactions like predation and competition. Leslie's matrix model is focused on projecting the growth of age-structured populations. Simple linear regression predicts a continuous variable from a single predictor, while multiple regression expands this by using two or more predictors. Correctly matching these models to their primary purposes is fundamental for selecting the right tool to analyze and understand complex ecological and environmental data.

246. (B) The typical or average distance of data points from their mean.
Standard deviation is the most widely used measure of dispersion in statistics. It provides a numerical value that represents the average amount by which individual observations in a dataset deviate from the arithmetic mean. A small standard deviation indicates that the data points are clustered closely around the center, while a large standard deviation suggests that the data is spread out over a wider range of values. This measure is essential for understanding the consistency and variability of any dataset.

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247. (D) The parameters to be estimated appear linearly in the equation.
In the context of statistical modeling, a model is defined as linear based on how the unknown parameters, such as coefficients and intercepts, are incorporated into the equation. For a model to be linear, these parameters must only be multiplied by independent variables or added together; they cannot be exponents, part of a trigonometric function, or divided by other parameters. This definition allows for complex relationships, like polynomial regression, to still be classified as linear models despite the independent variables themselves being squared.

248. (A) Non-negative (≥ 0)
In the Analysis of Variance, the F-statistic is calculated as the ratio of two variances: the variance between the group means and the variance within the groups. Because variance is based on the sum of squared deviations from the mean, it is mathematically impossible for any variance to be negative. Consequently, the ratio of two non-negative numbers will always result in a non-negative value. The F-statistic can be zero or positive, but it can never be a negative number.

249. (C) A continuous variable

17. The primary cause of global sea level rise associated with climate change is:
(A) Increased rainfall and river discharge into oceans.
(B) Thermal expansion of seawater and melting of land-based ice.
(C) Tectonic plate movements causing ocean floor subsidence.
(D) Increased evaporation from the ocean surface.

18. Given below are two statements:
Statement I : The Tehri Dam is located in the state of Himachal Pradesh.
Statement II : The Almatti Dam is a source of dispute related to water sharing on the Cauvery river.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

19. Which of the following is NOT a component of the 'Swachha Bharat Abhiyan'?
(A) Elimination of open defecation.
(B) Eradication of manual scavenging.
(C) Generation of solar power in rural areas.
(D) Municipal solid waste management.

20. Consider the following statements about the causes of major environmental disasters:
1. The Minamata disaster was caused by methylmercury poisoning.
2. The Bhopal Gas Disaster was caused by the release of methyl isocyanate (MIC).
3. The Chernobyl disaster was a nuclear accident.
4. The Fukushima Daiichi disaster was triggered by an earthquake and subsequent tsunami.
5. The Love Canal disaster involved volcanic eruption.

Which of the statements given above are correct?
(A) 1, 2, 3 and 4
(B) 1, 2, and 5
(C) 2, 3, 4 and 5
(D) 1, 3 and 4 only

21. 'Rainwater harvesting' is a technique primarily used for:
(A) Generating sustainable hydroelectricity through small-scale installations.
(B) Purifying contaminated river water for domestic drinking purposes.
(C) Storing rainwater for future use and recharging local groundwater.
(D) Preventing widespread soil erosion on steep agricultural hill slopes.

22. The term 'desertification' refers to the process by which:
(A) Draining wetlands for the expansion of urban residential development.
(B) Transforming fertile land into desert through drought and deforestation.
(C) Eroding coastal regions as a direct result of rising global sea levels.
(D) Retreating glaciers exposing barren land due to rising temperatures.

23. The 'Appiko movement' for forest conservation took place in which state of India?
(A) Uttarakhand
(B) Kerala
(C) Orissa
(D) Karnataka

24. What is the primary objective of the 'National Solar Mission'?
(A) To establish India as a global leader in solar energy.
(B) To mandate the use of solar water heaters in all new buildings.
(C) To replace all coal-based power plants with solar plants.
(D) To provide free solar panels to every household.

25. Arrange the following environmental disasters in chronological order of their occurrence:
1. Chernobyl Disaster
2. Minamata Disaster
3. Bhopal Gas Disaster
4. Fukushima Daiichi Disaster

Select the correct answer from the codes given below:
(A) 2, 3, 1, 4
(B) 1, 2, 3, 4
(C) 2, 1, 3, 4

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statistics like range, variance, and standard deviation describe how scattered the data is. This information is vital for understanding the consistency and variability of environmental measurements.

258. (A) Standard error measures the variability of sample means, while standard deviation measures the spread of individual data points in a sample.
The standard error of the mean differs from the standard deviation by estimating the variability of sample means rather than individual data points. While standard deviation describes the spread within a single sample, the standard error indicates the precision of the sample mean as an estimate for the population. It reflects how much the sample mean might vary across different samples.

259. (C) The typical deviation of a daily temperature reading from the mean temperature
Standard deviation is a common measure of dispersion that quantifies the average spread of data points around the arithmetic mean. A specific standard deviation value represents the typical deviation of any single measurement from the overall average. It is expressed in the same units as the original data, facilitating direct interpretation of the variability observed within the environmental readings collected.

260. (A) The mean is calculated as the arithmetic average and is sensitive to extreme values.
Descriptive statistics utilize the mean as a primary measure of central tendency, calculated as the arithmetic average of all values in a dataset. A key characteristic of the mean is its high sensitivity to extreme values or outliers, which can significantly shift its value. This sensitivity distinguishes it from more robust measures like the median in standard statistical data analysis.

261. (D) Asymmetry
The third central moment is a statistical parameter used to characterize the shape of a distribution by measuring its skewness. Skewness indicates the degree of asymmetry present in the data distribution relative to a central point. A non-zero value reveals whether the distribution has a longer tail extending toward the right or the left, signifying a lack of perfect symmetry.

262. (B) Negatively skewed
A distribution is described as negatively skewed when it features a longer tail extending to the left of the center. In such cases, the mean of the dataset is typically smaller than the median value. This asymmetry indicates that while most data points are concentrated on the higher end, there are several significantly lower values pulling the average value downward.

263. (C) The tailedness and peakedness relative to a normal distribution
Kurtosis is a fourth-order central moment that describes the tailedness and peakedness of a probability distribution in comparison to a normal distribution. It provides nuanced information about the shape of the distribution, specifically focusing on whether the data contains extreme outliers or if the central peak is more or less pronounced than what is observed in a standard bell curve.

264. (D) Platykurtic
In terms of kurtosis, a distribution is classified as platykurtic if it appears flatter and possesses lighter tails than a normal distribution. This shape suggests that the data is spread more thinly across a wider range with fewer extreme outliers. Such characteristics contrast with leptokurtic distributions, which are more peaked and have heavier tails than the standard normal model.

265. (A) The second central moment
Statistical moments are used to characterize the various features of a data distribution, such as location and shape. The second central moment specifically corresponds to the variance, which quantifies the dispersion of data points about the mean. While the first moment relates to the mean itself, the second moment provides a fundamental mathematical measure of how individual data points vary.

266. (B) To obtain a representative subset of a population for making valid inferences
Sampling theory provides the essential principles for selecting a subset of individuals from a larger population to estimate characteristics of the entire group. The primary goal is to obtain a representative sample that accurately reflects the population features. This allows environmental scientists to make valid inferences about the

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Quantitative variables are categorized as either discrete or continuous. Continuous variables can take any value within a range, including decimals and fractions, and are measured with tools that have varying levels of precision. Wingspan is a classic continuous variable because it can be measured as precisely as the equipment allows, such as fifteen point four centimeters. This contrasts with discrete variables, which only involve whole counts of separate units and cannot represent values between the integers.

250. (A) It assesses how well the model generalizes to new, independent data.
Model validation is an essential step in scientific research that evaluates the predictive accuracy of a model using an independent dataset that was not used during the calibration or fitting phase. Its primary goal is to determine if the model is truly useful for general application rather than just fitting a specific set of training data. Successful validation ensures that the model provides reliable forecasts and is not just a statistical fluke or the result of over fitting the original observations.

251. (B) Temperature in degrees Celsius
Interval scales possess ordered data with equal intervals between values but lack a true zero point. In certain thermal measurement systems, the zero value does not represent the absolute absence of heat. This makes such systems classic examples of interval scales, distinguishing them from ratio scales where an absolute zero indicates the complete absence of the characteristic measured by scientists.

252. (A) Nominal
The nominal scale involves the categorization of data into distinct and unordered groups. When classification relies on labels for different types of entities without an inherent rank or numerical value, it represents this basic measurement level. This method is fundamental for managing categorical information within scientific studies where order and magnitude are not applicable to the specific characteristic being recorded.

253. (C) An attribute is a qualitative characteristic, whereas a variable is a measurable quantity.
In environmental sciences, the distinction between attributes and variables is fundamental for data classification. An attribute refers to a qualitative characteristic that is categorized but cannot be measured numerically. Conversely, a variable is a characteristic that can be measured and assumes different numerical values. This differentiation ensures that researchers apply appropriate mathematical operations and statistical tests to their unique datasets.

254. (D) The categories have a clear order, but the magnitude of difference between them is not defined.
An ordinal scale introduces a specific rank or order among different categories, yet the intervals between these ranks are not necessarily equal or numerically defined. Establishing an order of intensity identifies a progression. However, the exact magnitude of difference between these qualitative levels remains unknown, which is the defining characteristic of ordinal data in environmental studies focusing on categorical assessments.

255. (C) Ratio scale
The ratio scale is considered the highest level of measurement because it possesses all properties of the interval scale while adding a true zero point. This meaningful zero allows for the calculation of ratios between values. Stating that one measurement is twice another is only possible when a zero value indicates the complete absence of the substance or characteristic being measured.

256. (B) The median
The median represents the middle value in an ordered dataset and is highly valued for its robustness in environmental analysis. Unlike the mean, which is sensitive to extreme values or outliers, the median provides a more reliable representation of typical conditions. It effectively resists the distorting influence of a few exceptionally high or low data points within a large dataset.

257. (D) To quantify the spread of data points around the center
Measures of dispersion are essential tools in descriptive statistics used to quantify the spread or variability of data points around a central value. While measures of central tendency identify a representative middle point, dispersion

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likelihood of data falling within specific ranges around the central mean of the dataset.

276. (A) Comparing the mean of a small sample to a known value when the population variance is unknown.
The t-distribution is most appropriate for hypothesis testing when researchers need to make inferences about a population mean using a small sample size. It is used when the population variance is unknown, necessitating the use of the sample variance instead. Its heavier tails account for the increased uncertainty that arises from relying on smaller datasets for estimation in scientific studies.

277. (D) Chi-square (χ^2) test for goodness of fit
The Chi-square test for goodness of fit is used to determine if an observed frequency distribution of categorical data matches a specific theoretical or expected distribution. In biological studies, this test can assess whether the recorded numbers of various items align with frequencies predicted from prior surveys. It evaluates the significance of the difference between observed and expected distribution counts.

278. (B) Analysis of Variance (ANOVA)
This specific distribution provides the theoretical foundation for Analysis of Variance. This statistical technique is used to compare the means of three or more independent groups by analyzing the ratio of variances between and within the groups. It is a positively skewed distribution defined by separate degrees of freedom related to the groups compared during the research and data analysis.

279. (C) It has heavier tails to account for uncertainty in small samples.
A key characteristic of the t-distribution is that it has heavier tails compared to the standard normal distribution. This feature is specifically designed to account for the additional uncertainty and variability associated with small sample sizes. As the size of the sample increases, the t-distribution eventually converges to the shape of the normal distribution, reflecting increased estimation precision and reliability.

280. (D) Chi-square (χ^2) distribution
The Chi-square distribution underpins tests designed to analyze categorical data, such as the presence or absence of an item across different categories. Specifically, the Chi-square test for independence determines whether there is a statistically significant association between two categorical variables. This makes it suitable for research exploring the relationship between biotic occurrences and various abiotic or physical environmental factors.

281. (A) Correlation measures the strength of a linear association, while regression models the relationship to make predictions.
Correlation and regression are distinct statistical methods used to explore relationships between variables. Correlation analysis measures the strength and direction of a linear association between two continuous variables, resulting in a coefficient. Regression analysis models this relationship to predict the value of a dependent variable based on predictors, producing a mathematical equation for the line of best fit in studies.

282. (B) A strong negative linear relationship, where higher temperatures are associated with lower fish populations.
A strong negative correlation coefficient indicates a substantial linear relationship between two variables. In environmental contexts, this suggests that as one variable increases, the other variable tends to decrease significantly. The value shows a high degree of predictability in how the variables move in opposite directions, although it does not prove a causal link between the factors studied.

283. (B) Multiple regression
Multiple regression is a statistical modeling technique used when an environmental response variable is influenced by several independent factors simultaneously. By incorporating two or more predictor variables, the model can explain more of the variance in the dependent variable. This approach provides a comprehensive view of complex systems by quantifying the relative contribution of each predictor to the final outcome.

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CHAPTER 10

Contemporary Environmental Issues

1. Which of the following is a primary global environmental issue characterized by the reduction in the variety of life forms within a given ecosystem or on the entire Earth?
(A) Sea level rise
(B) Biodiversity loss
(C) Ozone layer depletion
(D) Eutrophication

2. What is the primary objective of the 'National Mission for Enhanced Energy Efficiency' under the National Action Plan on Climate Change (NAPCC)?
(A) To unlock energy efficiency markets through innovative policy and regulatory regimes.
(B) To scale up national solar power capacity and promote renewable energy technology.
(C) To encourage the growth of sustainable urban infrastructure and green building design.
(D) To implement strategies for protecting and restoring the sensitive Himalayan ecosystem.

3. Given below are two statements:
Statement I : Eutrophication is the process of nutrient enrichment in a water body, leading to excessive growth of algae.
Statement II : Eutrophication ultimately improves the water quality for aquatic animals by increasing dissolved oxygen.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

4. The 'Chipko movement' was primarily a social-ecological movement focused on:
(A) Preventing the construction of large dams.
(B) Demanding stricter vehicular emission norms.
(C) Cleaning the Ganga river.
(D) Protecting trees and forests from being felled.

5. Consider the following statements regarding international environmental protection efforts:
1. They are exclusively focused on climate change.
2. They often involve treaties and conventions signed by multiple nations.
3. They are a recent phenomenon, starting only in the 21st century.
4. They aim to address transboundary environmental problems like ozone depletion.

Which of the statements given above are correct?
(A) 1 and 3 only
(B) 2 and 4 only
(C) 1, 2, and 3
(D) 2, 3, and 4

6. Which one of the following is NOT a direct method of water conservation?
(A) Rain water harvesting
(B) Inter-linking of rivers
(C) Development of watersheds
(D) Ground water recharge

7. The controversy surrounding the Narmada Dam project primarily involved which of the following issues?
(A) Trans boundary water sharing between India and Pakistan.
(B) Depletion of the ozone layer due to project activities.
(C) Contamination of the river with industrial mercury.
(D) Large-scale displacement of people and submergence of forests.

8. What does GRIHA stand for in the context of sustainable habitats in India?

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simultaneously influence the outcome, providing a more comprehensive predictive tool.

293. (D) Forecasting
Predictive science involves using a validated mathematical model to estimate future environmental states or outcomes under different scenarios. By applying projected inputs to a model, scientists can estimate future impacts such as changes in natural levels. This process is a vital tool for long-term planning, environmental management, and the development of sustainable policy frameworks to address potential upcoming global challenges.

294. (B) Modeling the relationship between water temperature and the dissolved oxygen level in a lake.
A simple linear regression model is best suited for scenarios where a researcher wants to establish a straight-line relationship between a single predictor variable and a response variable. It focuses on the direct effect of one factor on another, assuming that other potential variables are constant. This approach allows for clear quantification of the interaction between two specific environmental characteristics.

295. (C) To simulate and predict the behavior of environmental systems.
A primary goal of developing environmental models is to simulate and predict the behavior of complex systems. These models provide quantitative tools that help scientists understand how various factors interact and influence environmental outcomes. By creating mathematical representations of real-world processes, researchers can test different scenarios and forecast future changes, which is essential for effective environmental management and informed decision-making.

296. (D) Predator-prey interactions
This foundational ecological tool is primarily used to describe the dynamics of interacting species. It uses mathematical equations to illustrate how the populations of two groups fluctuate in a cyclical pattern over time. The model demonstrates how the growth of one group is limited by consumption from another, while the consuming population growth depends on the availability of its resource.

297. (A) It incorporates the age structure of a single population.
This specific model is distinguished by its focus on the internal structure of a single population. While other models examine interactions between different species, this approach is discrete and uses matrix algebra to project future size and composition. It accounts for how different life stages contribute to overall growth and survival, making it invaluable for species where age is critical.

298. (B) Age-specific survival and fecundity rates
This matrix is the core component of an age-structured population model, containing vital statistics for each age class. It specifically includes age-specific survival rates, which represent the probability of moving to the next age class, and fecundity rates, which measure average offspring production. These parameters allow researchers to forecast how a population size and age distribution will change over time.

299. (B) First-order nonlinear differential equations
Mathematically, this foundational ecological model is represented as a pair of first-order, nonlinear differential equations. These equations are coupled, meaning the rate of change in one population depends on the current size of both groups. This mathematical structure allows the model to capture the complex, oscillating feedback loops inherent in many natural systems involving interacting species across different trophic levels.

300. (A) Leslie's matrix model
This matrix approach is the most suitable tool for predicting population changes while considering different survival and reproductive rates across various age classes. Because it uses age-specific fecundity and survival data, it can accurately project the future composition of a species where younger and older individuals have vastly different roles in the long-term sustainability and growth of the biological group.

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284. (A) Concluding that a strong correlation between two variables proves a cause-and-effect relationship.
A critical misinterpretation in statistical analysis is assuming that a strong correlation between two variables proves a cause-and-effect relationship. Correlation merely quantifies the degree to which two variables move together linearly; it does not identify the underlying mechanism. Researchers must exercise caution and use additional experimental evidence before concluding that one variable causes changes in the other in studies.

285. (C) An equation that models the relationship between variables
The primary output of regression analysis is a mathematical equation that defines the line or plane of best fit for a dataset. This equation allows researchers to model the relationship between variables and make specific predictions about the dependent variable. This predictive capacity distinguishes regression from correlation, which only provides a coefficient indicating the strength and direction of an association.

286. (D) It is a statement of no effect or no difference that is tested against.
In hypothesis testing, the null hypothesis serves as a formal statement of no effect or no difference between groups or variables. It represents the baseline assumption that the researcher aims to challenge or disprove using sample data. The entire statistical procedure is designed to determine if there is enough evidence to reject this hypothesis in favor of an alternative theory.

287. (C) The null hypothesis should be rejected.
When a researcher obtains a p-value that is less than the pre-determined significance level, the appropriate statistical conclusion is to reject the null hypothesis. If the calculated probability is below the standard threshold of 0.05, it indicates that the observed results are unlikely to have occurred by chance alone if the null hypothesis were true for the population.

288. (B) We are 95% confident that the true population mean concentration lies between 10.2 and 11.8 ppm.
A ninety-five percent confidence interval provides a range of values within which the true population parameter is likely to reside. Stating that an interval is between specific numerical limits means researchers are ninety-five percent confident the actual population mean falls within these bounds. It reflects the precision of the estimate derived from the sample data used in the analysis.

289. (D) When comparing the means of two groups.
A t-test is an appropriate statistical procedure when the research objective is to compare the means of two distinct groups. This test determines if the difference between the sample means is statistically significant or if it could have occurred due to random sampling variation. It is widely used in environmental studies to assess the impact of different treatments or conditions.

290. (A) The threshold probability for deciding to reject the null hypothesis.
The significance level, denoted by alpha, represents the threshold probability used by researchers to decide whether to reject the null hypothesis. It is the maximum risk one is willing to take of rejecting the null hypothesis when it is actually true. Commonly set at 0.05, it defines the critical region for determining statistical significance in various tests.

291. (C) To assess the model's accuracy using an independent dataset.
Model validation is a critical stage in the environmental modeling process that involves assessing a model's performance and accuracy. This is achieved by testing the model's predictions against a new, independent dataset that was not used during the initial development phase. Validation ensures that the model is reliable and generalizable before it is applied to real-world forecasting or management decisions.

292. (A) It incorporates two or more predictor variables to explain a response.
Multiple regression models differ from simple linear regression by incorporating two or more predictor variables to explain the variance in a single response variable. While simple regression only looks at the relationship between one independent and one dependent variable, multiple regression allows for the analysis of complex phenomena where several factors

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(A) Green Rating for Integrated Habitat Assessment
(B) Green Residential and Industrial Habitat Assessment
(C) Global Rating for Indian Housing and Architecture
(D) Green Regulation for Internal Housing Affairs

9. The environmental disaster at Love Canal, USA, was primarily related to:
(A) A nuclear reactor meltdown.
(B) A massive oil spill in a waterway.
(C) The leakage of buried industrial chemical waste.
(D) The release of a toxic gas from a pesticide plant.

10. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The National Action Plan on Climate Change (NAPCC) includes a mission for a 'Green India'.
Reason (R) : The 'Green India' mission aims to increase forest cover and improve the quality of existing forests as a climate change adaptation and mitigation strategy.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

11. Which epidemiological issue is caused by the excessive consumption of fluoride, often through drinking water?
(A) Goitre
(B) Arsenocosis
(C) Dengue
(D) Fluorosis

12. The 'Namami Gange' program is a national mission aimed at the conservation and rejuvenation of which river?
(A) Yamuna
(B) Ganga
(C) Narmada
(D) Mahanadi

13. Which of the following statements correctly defines a 'carbon credit'?
(A) A financial loan provided to industries for adopting low-carbon industrial technologies.
(B) A mandatory tax imposed on the volume of carbon dioxide emissions by companies.
(C) A tradable permit representing the right to emit one tonne of carbon dioxide.
(D) A government subsidy provided to facilities for using local renewable energy sources.

14. The 'Silent Valley movement' in Kerala was aimed at protecting a tropical evergreen forest from being flooded by which type of project?
(A) A nuclear power plant
(B) A large-scale industrial complex
(C) A commercial monoculture plantation
(D) A hydro-power project

15. Match List I with List II regarding conservation projects and their primary focus.
List I: (Conservation Project)
P. Project Tiger
Q. Project Elephant
R. GOI-UNDP Sea Turtle Project
S. Indo-Rhino Vision
List II: (Primary Focus)
1. Conservation of Olive Ridley turtles
2. Protection of tigers and their habitats
3. Attaining a wild population of at least 3,000 greater one-horned rhinos
4. Ensuring the long-term survival of elephant populations in their natural habitats
Codes:
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-2, R-3, S-1

16. Which of the eight missions under the National Action Plan on Climate Change (NAPCC) is specifically dedicated to understanding the science of climate change and strengthening the climate science research infrastructure in the country?
(A) National Solar Mission
(B) National Mission on Strategic Knowledge for Climate Change
(C) National Mission for a 'Green India'
(D) National Mission for Sustainable Habitat

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whole population without needing to analyze every single individual or item.

267. (B) It offers a framework for quantifying the uncertainty associated with events.
Basic probability theory serves as the mathematical foundation for inferential statistics by providing a framework to quantify uncertainty. It defines the likelihood of specific events occurring on a scale from zero to one. This quantification is necessary for understanding random variation in environmental data and is essential for the construction and interpretation of various statistical tests and predictive models.

268. (A) The conclusions drawn about the population will be invalid.
Using a non-representative sample in environmental research leads to biased results and invalid inferences about the population. If a sample's characteristics do not accurately reflect the broader group, any conclusions drawn from the data will be flawed. Ensuring representativeness is a critical step in the sampling process to maintain the scientific reliability and accuracy of the final study outcomes.

269. (C) Sampling error
Sampling error refers to the inherent discrepancy that exists between a statistic calculated from a sample and the actual parameter of the population it represents. While researchers use appropriate techniques to minimize this error, it cannot be entirely eliminated due to the nature of sampling. Quantifying this error is vital for determining the precision and reliability of any statistical estimates.

270. (D) A list or map of all items from which a sample is selected
A sampling frame is a fundamental component of the sampling process, defined as a comprehensive list or map of all items from which a sample is selected. It serves as the physical or conceptual boundary of the population under study. A well-defined frame is necessary to ensure that every individual has a known chance of being included in the research sample.

271. (C) Poisson distribution
This specific probability distribution is designed to model the number of times an event occurs within a defined interval of time or space. It is particularly useful for modeling counts of rare events or organisms per unit area. This makes it an ideal tool for ecological studies involving spatial distributions and frequencies where individual occurrences are relatively infrequent and independent.

272. (B) Because pollutant data are often right-skewed and cannot be negative.
Many environmental variables are inherently non-negative and often exhibit a right-skewed distribution. The log-normal distribution is frequently a better fit than the normal distribution because it is defined only for positive values and accommodates skewness. It effectively models data that spans several orders of magnitude, which is common in chemical and biological measurements within natural systems.

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273. (D) Binomial distribution
This distribution models the number of successes observed in a fixed number of independent trials, where each trial has the same probability of success. In environmental testing, checking a specific number of samples for the presence or absence of a trait fits these criteria. It provides a mathematical way to calculate probabilities for discrete outcomes in various categorical scientific assessments.

274. (A) The logarithm of the variable is normally distributed.
A variable follows a log-normal distribution if the natural logarithm of its values results in a normal distribution. This characteristic defines the distribution behavior, making it suitable for positive-only data that is right-skewed. It is a continuous probability distribution widely applied in environmental sciences to represent variables that cannot have negative values and show significant variability across many observations.

275. (C) Normal distribution
The Normal distribution is a symmetric, bell-shaped probability distribution defined by its mean and standard deviation. It serves as the paramount model for many continuous variables in statistics and forms the theoretical basis for numerous parametric tests. Its properties allow researchers to make predictions about the

(D) 3, 2, 4, 1

26. A 'People's Biodiversity Register' is a comprehensive record of local biodiversity and associated knowledge. Who is primarily responsible for its preparation and maintenance at the local level?
(A) The Biodiversity Management Committee (BMC)
(B) The State Forest Department
(C) The National Biodiversity Authority
(D) Non-Governmental Organizations

27. The Ramsar Convention is an international treaty for the conservation and sustainable use of:
(A) Deserts
(B) Tropical Rainforests
(C) Coral Reefs
(D) Wetlands

28. Given below are two statements:
Statement I : Vehicular emission norms in India are progressively tightened to reduce air pollution from vehicles.
Statement II : GRIHA rating norms are used to certify the emission levels of vehicles.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

29. The dispute over the Almatti Dam primarily involves water sharing of the Krishna River between which states?
(A) Tamil Nadu and Kerala
(B) Karnataka, Andhra Pradesh, and Maharashtra
(C) Odisha and Chhattisgarh
(D) Punjab and Haryana

30. Consider the following key focal areas of the 'National Mission for Sustainable Agriculture' (NMSA):
1. Enhancing food security.
2. Making agriculture more resilient to climate change.
3. Reducing the number of farmers in the country.
4. Promoting the export of all agricultural produce.

Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 2 and 4 only
(C) 1, 3, and 4
(D) 3 and 4 only

31. Crocodile Conservation projects in India were launched with a primary focus on which three species?
(A) Nile crocodile, American alligator, and Gharial
(B) Mugger, Caiman, and Saltwater crocodile
(C) Estuarine crocodile, Indian python, and Gharial
(D) Saltwater crocodile, Mugger, and Gharial

32. The process of land reclamation primarily deals with:
(A) Restoring damaged or degraded land to a functional, usable state.
(B) Increasing total national forest cover through aggressive plantation.
(C) Acquiring private land for building large-scale infrastructure projects.
(D) Converting fertile agricultural land for new residential purposes.

33. Which of the following is the most appropriate description of a 'Green Building'?
(A) A building surrounded by a large garden.
(B) A structure designed and operated to minimize negative environmental impact.
(C) A government building dedicated to the Ministry of Environment.
(D) A building constructed entirely of wood.

34. The Yamuna Action Plan was launched to address the issue of:
(A) Flood control along the Yamuna basin.
(B) Navigation and shipping in the Yamuna.
(C) Pollution in the Yamuna River.
(D) Hydropower generation on the Yamuna.

35. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The National Water Mission

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54. Identify the incorrect statement regarding global environmental issues.
(A) Climate change leads to an increase in the frequency of extreme weather events.
(B) Ozone layer depletion is primarily caused by greenhouse gases like carbon dioxide and methane.
(C) Biodiversity loss weakens the ability of ecosystems to provide essential services.
(D) Sea level rise threatens coastal communities and ecosystems.

55. Consider the following environmental conservation movements in India:
1. Chipko Movement
2. Appiko Movement
3. Silent Valley Movement
4. Gandhamardhan Movement

Which of these were primarily focused on forest/tree conservation?
(A) 1 and 2 only
(B) 1, 2, 3 and 4
(C) 3 and 4 only
(D) 1, 2 and 4 only

56. The 'National Mission for Sustainable Habitat', as part of the National Action Plan on Climate Change (NAPCC), focuses on which key area?
(A) Increasing national forest cover.
(B) Making agriculture more climate-resilient.
(C) Improving the scientific knowledge of climate change.
(D) Promoting energy efficiency as a core component of urban planning.

57. The restoration of lakes suffering from eutrophication often involves which of the following actions?
(A) Reducing the inflow of nutrients and removing excess algal bloom.
(B) Adding more fertilizers to promote plant growth.
(C) Introducing invasive fish species.
(D) Increasing the water temperature to kill algae.

58. What is the primary purpose of introducing vehicular emission norms in India?
(A) To increase the fuel efficiency of vehicles.
(B) To standardize the design and colour of all vehicles.
(C) To regulate and reduce the amount of pollutants emitted by vehicles.
(D) To promote the sale of electric vehicles through subsidies.

59. The nuclear disaster at Chernobyl in 1986 occurred in which present-day country?
(A) Ukraine
(B) Russia
(C) Belarus
(D) Kazakhstan

60. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Arsenocosis is a significant public health problem in some parts of India, particularly in the Gangetic plains.
Reason (R) : It is caused by prolonged exposure to high levels of arsenic, often through contaminated groundwater.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

61. Which of the following best defines 'soil erosion'?
(A) The process of soil formation from parent rock.
(B) The enrichment of soil with organic matter.
(C) The artificial reclamation of degraded land.
(D) The displacement of the upper layer of soil; a form of soil degradation.

62. 'Project Elephant' was launched by the Government of India with the aim of:
(A) Training domesticated elephants for heavy forestry labor.
(B) Supporting states in protecting elephants, habitats, and corridors.
(C) Promoting elephant tourism within Indian national parks.
(D) Establishing breeding centers for elephants in municipal zoos.

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63. Given below are two statements:
Statement I : The Cauvery and Mahanadi river water disputes are examples of environmental

(A) To assess the health status of the Himalayan ecosystem.
(B) To develop a coherent database on the Himalayan ecosystem.
(C) To assist states in implementing sustainable development actions.
(D) To promote hydro-power projects in the region.

45. Consider the following wildlife conservation projects in India:
1. Project Tiger
2. Vulture Conservation Project
3. Project Elephant
4. Crocodile Conservation
5. Indo-Rhino Vision

Which of the statements given above are correct?
(A) 1, 2, 3, and 4
(B) 1, 3, 4, and 5
(C) 1, 2, 4, and 5
(D) 2, 3, 4, and 5

46. The Minamata disaster in Japan was a severe neurological syndrome caused by poisoning from which substance?
(A) Lead
(B) Cadmium
(C) Dioxin
(D) Methylmercury

47. 'Watershed development' is a strategy primarily aimed at:
(A) Dividing river basins into smaller administrative management units.
(B) Conserving and judiciously using resources within a natural watershed.
(C) Constructing large dams and reservoirs across major national rivers.
(D) Preventing flooding in downstream urban and residential areas.

48. Given below are two statements:
Statement I : A GRIHA rating is a measure of a building's performance against nationally acceptable benchmarks for environmental impact.
Statement II : A higher GRIHA rating indicates a poorer environmental performance of the building.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

49. 'Indo-Rhino Vision' is a conservation initiative with the primary goal of increasing the population of which species in the state of Assam?
(A) Greater One-horned Rhinoceros
(B) Sumatran Rhinoceros
(C) Black Rhinoceros
(D) Javan Rhinoceros

50. Which of the following is the best example of 'carbon sequestration'?
(A) Burning fossil fuels in a power plant.
(B) A growing forest absorbing CO_2 from the atmosphere.
(C) A vehicle emitting CO_2 from its exhaust.
(D) The process of creating carbon credits for sale.

51. The Bhopal Gas Disaster of 1984 involved the leakage of which highly toxic gas?
(A) Phosgene
(B) Chlorine
(C) Methyl isocyanate (MIC)
(D) Sulphur dioxide

52. The National Action Plan on Climate Change (NAPCC) comprises how many national missions?
(A) Six
(B) Ten
(C) Twelve
(D) Eight

53. Hydro-power projects in Jammu & Kashmir, Himachal, and North-Eastern States have often been controversial due to concerns related to:
(A) Ozone layer depletion.
(B) Marine pollution and its impact on fisheries.
(C) Ecological fragility, seismic risks, and displacement.
(D) Increased desertification in surrounding areas.

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Reason (R) : Watershed management helps in soil and moisture conservation, groundwater recharge, and improving land productivity.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

111. What is the fundamental principle of 'rainwater harvesting'?
(A) To prevent rain from falling in certain areas.
(B) To capture and store rainwater where it falls for future use or groundwater recharge.
(C) To chemically treat rainwater to make it potable.
(D) To divert all rainwater directly into rivers to prevent flooding.

112. The National River Conservation Plan (NRCP) is the over arching framework for which of the following initiatives?
(A) Project Tiger and Project Elephant
(B) Namami Gange and Yamuna Action Plan
(C) Swachha Bharat Abhiyan
(D) National Solar Mission

113. Which of the following is a direct consequence of eutrophication in a lake?
(A) Increase in water transparency.
(B) Proliferation of desirable fish species.
(C) Depletion of dissolved oxygen, leading to fish kills.
(D) Decrease in water temperature.

114. The People's Biodiversity Register (PBR) is mandated under which Indian legislation?
(A) The Environment (Protection) Act, 1986
(B) The Forest (Conservation) Act, 1980
(C) The Water (Prevention and Control of Pollution) Act, 1974
(D) The Biological Diversity Act, 2002

115. Match List I with List II regarding environmental terms and their descriptions.
List I: (Term)
P. Carbon Sequestration
Q. Carbon Credit
R. Green Building
S. Eutrophication

List II: (Description)
1. A tradable permit to emit one tonne of CO_2
2. Nutrient enrichment of a water body
3. A resource-efficient and environmentally responsible structure
4. The process of capturing and storing atmospheric CO_2

Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-1, R-3, S-2
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-4, R-3, S-1

116. The Crocodile Conservation Project in India focuses on the breeding and management of:
(A) Only the saltwater crocodile.
(B) Only the Gharial.
(C) The Mugger and American Alligator.
(D) The Gharial, Saltwater Crocodile, and Mugger.

117. Which of the eight missions of the NAPCC is directly related to promoting energy efficiency in buildings, solid waste management, and a shift to public transport?
(A) National Mission for Enhanced Energy Efficiency
(B) National Mission for Sustainable Habitat
(C) National Mission for a 'Green India'
(D) National Solar Mission

118. Given below are two statements:
Statement I : Sea level rise is a uniform phenomenon, occurring at the same rate everywhere on the globe.
Statement II : Thermal expansion of ocean water is one of the major contributors to sea level rise.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

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119. The environmental movement in the Silent Valley of Kerala was a struggle to save the region's unique biodiversity from:
(A) A bauxite mining project.

issues related to water resource projects.
Statement II : These disputes primarily revolve around the allocation and sharing of river water among different states.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

64. The concept of a 'Green Building' is most closely associated with which of the following?
(A) Swachha Bharat Abhiyan
(B) National River Conservation Plan
(C) Project Tiger
(D) Sustainable Habitat

65. Match List I with List II regarding environmental movements and their associated state/region.
List I: (Environmental Movement)
P. Chipko Movement
Q. Silent Valley Movement
R. Appiko Movement
S. Gandhamardhan Movement
List II: (Associated State/Region)
1. Kerala
2. Uttarakhand (then Uttar Pradesh)
3. Odisha
4. Karnataka
Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-4, Q-3, R-2, S-1
(D) P-2, Q-4, R-1, S-3

66. The Fukushima Daiichi nuclear disaster in 2011 was triggered by:
(A) A human operational error.
(B) A major earthquake and subsequent tsunami.
(C) A terrorist attack.
(D) A volcanic eruption.

67. Which of the following is an example of an international effort for environmental protection?
(A) The National Action Plan on Climate Change (NAPCC).
(B) The Ramsar Convention on Wetlands.
(C) The Yamuna Action Plan.
(D) The Swachha Bharat Abhiyan.

68. The primary objective of the 'National Water Mission' under the NAPCC is to:
(A) Manage water resources for conservation and equitable distribution.
(B) Build a network of new dams across all major Indian river systems.
(C) Privatizing water supply services in all major urban and metro areas.
(D) Cleaning the pollution in the Ganga and Yamuna river basins exclusively.

69. In the context of climate change, 'food security' is threatened because:
(A) International trade agreements prioritize industrial goods over food items.
(B) The use of chemical fertilizers is being banned globally.
(C) Climate change causes unpredictable farming and reduced crop yields.
(D) The world population is decreasing, leading to less demand for food.

70. Consider the following statements regarding the National Action Plan on Climate Change (NAPCC):
1. It was launched by the Prime Minister's Council on Climate Change.
2. It comprises a total of eight national missions.
3. Its sole focus is on reducing India's greenhouse gas emissions.
4. It aims to guide India's response to climate change at the national level.
5. The 'Namami Gange' program is one of the eight missions.
Which of the statements given above are correct?
(A) 1, 2 and 3
(B) 1, 2 and 4
(C) 2, 4 and 5
(D) 1, 3 and 5

71. The reclamation of degraded land can be achieved through methods like:
(A) Increasing the intensity of chemical fertilizer use.
(B) Converting the land for industrial use.
(C) Uncontrolled grazing by livestock.

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(D) Afforestation and preventing soil erosion.

72. Which of the following diseases is NOT directly linked to water or vector-borne issues?
(A) Fluorosis
(B) Goitre
(C) Dengue
(D) Arsenocosis

73. The 'Swachha Bharat Abhiyan' is a nationwide cleanliness campaign with a significant focus on:
(A) Reducing air pollution from industries.
(B) Conserving biodiversity in national parks.
(C) Promoting renewable energy sources.
(D) Waste management and sanitation.

74. 'Project Tiger', one of India's most successful conservation ventures, was launched to:
(A) Protect the Bengal tiger and its habitat from extinction.
(B) Increase the tiger population for tourism purposes only.
(C) Capture tigers and relocate them to zoos.
(D) Study the behavior of tigers in captivity.

75. Arrange the following forest conservation movements in the approximate chronological order of their beginning:
1. Silent Valley movement
2. Chipko movement
3. Appiko movement
4. Gandhamardhan movement

Select the correct answer from the codes given below:
(A) 1, 2, 3, 4
(B) 2, 1, 3, 4
(C) 2, 3, 1, 4
(D) 1, 3, 2, 4

76. The concept of 'Carbon Sequestration' relates to:
(A) The measurement of an individual's carbon footprint.
(B) The trading of carbon emission permits.
(C) The release of carbon from burning fossil fuels.
(D) Capturing and storing atmospheric carbon dioxide long-term.

77. The GRIHA rating system is specifically designed for:
(A) Certifying organic agricultural products.
(B) Assessing the environmental performance of buildings.
(C) Rating the emission standards of vehicles.
(D) Evaluating the water quality of rivers.

78. Given below are two statements:
Statement I : The primary goal of a People's Biodiversity Register is to document local biodiversity and traditional knowledge.
Statement II : This documentation helps in ensuring equitable sharing of benefits arising from the use of these resources.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

79. The Yamuna Action Plan, similar to the Namami Gange project, is part of the larger:
(A) National Action Plan on Climate Change.
(B) National Mission for Sustainable Agriculture.
(C) National River Conservation Plan.
(D) Swachha Bharat Abhiyan.

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80. Consider the following statements regarding aspects of 'Sustainable Habitat':
1. It includes the concept of 'Green Buildings'.
2. It is one of the missions under the NAPCC.
3. It uses rating systems like GRIHA to evaluate environmental performance.
4. It is exclusively concerned with rural housing.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3
(B) 2 and 4 only
(C) 1 and 3 only
(D) 1, 2, 3 and 4

81. A major concern regarding hydro-power projects in the North-Eastern states of India is their potential impact on:
(A) The region's rich biodiversity and indigenous communities.
(B) The desertification of adjacent plains.
(C) The depletion of the ozone layer.

(D) The international price of crude oil.

82. The 'National Mission for a Green India' primarily aims to:
(A) Promote the use of green-colored vehicles.
(B) Increase forest cover and protect/restore forest ecosystems.
(C) Mandate the painting of all government buildings green.
(D) Develop green tourism circuits in the country.

83. Chronic exposure to arsenic in drinking water leads to which health condition?
(A) Fluorosis
(B) Goitre
(C) Arsenocosis
(D) Dengue

84. The control of desertification can involve which of the following measures?
(A) Increasing regional deforestation and livestock overgrazing.
(B) Monoculture farming using high water-consuming crop types.
(C) Expanding new urban infrastructure into sensitive arid zones.
(D) Implementing sustainable land and water management practices.

85. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The Chipko movement was a significant environmental movement in India.
Reason (R) : It was a movement against the construction of large dams in the Himalayan region.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

86. Which of the following is an example of 'in-situ' wildlife conservation?
(A) Crocodile conservation in captive breeding centers.
(B) Establishment of a tiger reserve under 'Project Tiger'.
(C) Maintaining a People's Biodiversity Register.
(D) Conducting research in a zoological park.

87. Which of the following environmental issues is directly linked to the release of chlorofluorocarbons (CFCs) into the atmosphere?
(A) Climate Change
(B) Sea level rise
(C) Eutrophication
(D) Ozone layer depletion

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88. Given below are two statements:
Statement I : The National Mission for Sustainable Agriculture (NMSA) focuses on making Indian agriculture more resilient to climate change.
Statement II : The mission achieves this by exclusively promoting the use of genetically modified crops.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

89. A key component of the 'Swachha Bharat Abhiyan' is achieving an 'Open Defecation Free' (ODF) status. This is primarily aimed at improving:
(A) Sanitation and public health.
(B) Air quality and visibility.
(C) Forest cover and biodiversity.
(D) River water flow rates.

90. Match List I with List II regarding environmental disasters and their year of occurrence.
List I: (Disaster)
P. Bhopal Gas Disaster
Q. Chernobyl Disaster
R. Fukushima Daiichi Disaster
S. Love Canal Disaster
List II: (Year of Occurrence)
1. 1986
2. 2011
3. 1978
4. 1984
Codes:

aims to improve water use efficiency.
Reason (R) : Increasing water use efficiency helps in managing water scarcity, which is expected to be exacerbated by climate change.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

36. Goitre, an enlargement of the thyroid gland, is an epidemiological issue primarily linked to a deficiency of which element?
(A) Iron
(B) Fluoride
(C) Iodine
(D) Arsenic

37. The GOI-UNDP Sea Turtle Project was initiated to conserve which species on the coast of Odisha?
(A) Leatherback Sea Turtle
(B) Olive Ridley Turtle
(C) Hawksbill Sea Turtle
(D) Green Sea Turtle

38. Given below are two statements:
Statement I : Carbon sequestration is the process of releasing stored carbon into the atmosphere.
Statement II : Carbon credits are financial instruments that allow the holder to emit a certain amount of carbon dioxide.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

39. The environmental movement against the Gandhamardhan bauxite mining project occurred in which Indian state?
(A) Jharkhand
(B) Chhattisgarh
(C) West Bengal
(D) Odisha

40. Match List I with List II regarding National Missions under the NAPCC and their core objectives.
List I: (National Mission under NAPCC)
P. National Solar Mission
Q. National Water Mission
R. National Mission for a 'Green India'
S. National Mission for Sustainable Habitat
List II: (Core Objective)
1. Conservation of water and minimizing wastage
2. Promoting energy efficiency in buildings and urban planning
3. Enhancing carbon sinks through afforestation
4. Promoting the generation of solar power
Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-2, S-1
(C) P-4, Q-1, R-3, S-2
(D) P-3, Q-4, R-1, S-2

41. Which of the following best describes the problem addressed by the National River Conservation Plan?
(A) Construction of dams for irrigation.
(B) Inter-state disputes over river water sharing.
(C) Promotion of inland water transport.
(D) Abatement of pollution in rivers.

42. Dengue fever is an epidemiological issue caused by a virus transmitted by which vector?
(A) Anopheles mosquito
(B) Aedes mosquito
(C) Culex mosquito
(D) Sandfly

43. In the context of climate change, 'adaptability' refers to:
(A) Reducing greenhouse gas emissions to prevent further climate change.
(B) Sequestering carbon from the atmosphere through healthy ecosystems.
(C) Adjusting systems to moderate damages or cope with climate impacts.
(D) Managing international legal frameworks for climate change negotiations.

44. Which of the following is NOT a primary goal of the 'National Mission for Sustaining the Himalayan Ecosystem'?

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vehicle exhaust.

101. The 'Namami Gange' programme is an Integrated Conservation Mission. Which of the following is one of its key pillars?
(A) Building hydro-electric projects on the Ganga.
(B) Creating sewerage treatment infrastructure.
(C) Promoting large-scale fishing.
(D) Inter-linking Ganga with southern rivers.

102. Which of the following movements is a direct parallel to the Chipko movement, but occurred in the state of Karnataka?
(A) Silent Valley movement
(B) Narmada Bachao Andolan
(C) Gandhamardhan movement
(D) Appiko movement

103. The term 'energy security' in the context of climate change implies:
(A) Ensuring a reliable, affordable supply of energy, with an increasing focus on sustainable and low-carbon sources.
(B) Ensuring a nation has a 100% supply of energy from fossil fuels.
(C) Securing national borders against energy-related conflicts.
(D) The complete privatization of the energy sector.

104. Which of the following represents a key strategy for the 'reclamation of degraded land'?
(A) Allowing uncontrolled grazing.
(B) Converting the land for urban sprawl.
(C) Afforestation and soil conservation measures.
(D) Extracting remaining minerals from the soil.

105. Consider the following objectives of the 'National Mission for Sustaining the Himalayan Ecosystem':
1. To continuously assess the health status of the Himalayan ecosystem.
2. To launch a major afforestation drive in the plains of India.
3. To develop a database on Himalayan resources.
4. To assist in the implementation of sustainable development actions for the region.

Which of the above statement(s) is/are correct?
(A) 1, 2 and 3
(B) 2, 3 and 4
(C) 1, 3 and 4
(D) 1, 2 and 4

106. The GOI-UNDP Sea Turtle project focuses primarily on protecting the mass nesting sites of Olive Ridley turtles, also known as:
(A) Rookeries
(B) Colonies
(C) Flotillas
(D) Arribadas

107. Which of the following statements about 'Ramsar sites' is incorrect?
(A) They are wetlands of international importance.
(B) Only rivers can be designated as Ramsar sites.
(C) India has several designated Ramsar sites.
(D) The designation is part of the Ramsar Convention.

108. The 'Indo-Rhino Vision 2020' program aimed to achieve a wild population of at least 3,000 greater one-horned rhinos spread over seven protected areas in which Indian state?
(A) West Bengal
(B) Uttar Pradesh
(C) Assam
(D) Bihar

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109. The primary environmental concern associated with large water resource projects like the Narmada and Tehri dams is:
(A) The emission of greenhouse gases during construction.
(B) The impact on local weather patterns.
(C) The pollution of groundwater resources.
(D) Submergence of large areas of forests and agricultural land, and displacement of communities.

110. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : Development of watersheds is a key component of water conservation strategy in India.

(A) P-1, Q-4, R-2, S-3
(B) P-4, Q-2, R-1, S-3
(C) P-4, Q-1, R-2, S-3
(D) P-2, Q-1, R-3, S-4

91. Which of the following is NOT one of the eight missions under the National Action Plan on Climate Change (NAPCC)?
(A) National Mission for Sustaining the Himalayan Ecosystem.
(B) National Mission for a 'Green India'.
(C) National Mission for Sustainable Agriculture.
(D) National Mission for Clean Ganga.

92. The dispute over the Tehri Dam was heightened due to its location in a region known for:
(A) Being a desert ecosystem.
(B) High seismic activity.
(C) Having a high concentration of endangered marine life.
(D) Frequent volcanic eruptions.

93. The term 'Ramsar Sites' refers to:
(A) Sites of global geological importance.
(B) Ancient monuments protected by UNESCO.
(C) Wetlands of international importance.
(D) Nuclear-free zones.

94. 'Climate change adaptability' is a concept that focuses on:
(A) Stopping climate change from happening.
(B) Assigning blame for the causes of climate change.
(C) Marketing new green technologies.
(D) Adjusting to the current and future effects of climate change.

95. Consider the following consequences of global climate change:
1. Sea level rise
2. Increased frequency of extreme weather events
3. Ozone layer depletion
4. Loss of biodiversity
5. Acid rain

Which of the statements given above are correct?
(A) 1, 2, and 4
(B) 1, 3, and 5
(C) 2, 3, and 4
(D) 1, 2, 4, and 5

96. The main objective of the National Mission on Strategic Knowledge for Climate Change is:
(A) To directly fund renewable energy projects.
(B) To build a vibrant and dynamic knowledge system for the country.
(C) To lead afforestation drives across the country.
(D) To implement energy efficiency measures in industries.

97. The 'Gandhamardhan movement' in Odisha was a protest against:
(A) The establishment of a nuclear power plant.
(B) Bauxite mining that threatened local ecology and livelihoods.
(C) The construction of a large dam.
(D) The felling of trees for a railway line.

98. Given below are two statements:
Statement I : The primary goal of 'Project Elephant' is to protect wild elephant populations and their habitats.
Statement II : This includes the development and management of elephant corridors to allow for their migration.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

99. The controversy over hydro-power projects in states like Jammu & Kashmir and Himachal Pradesh often includes which of the following concerns?
(A) Increased air pollution.
(B) Salinization of agricultural land.
(C) Disruption of marine ecosystems.
(D) Risks in a geologically sensitive and seismic Himalayan zone.

100. Vehicular emission norms in India, such as Bharat Stage (BS) standards, are designed to:
(A) Mandate specific fuel efficiency levels (mileage).
(B) Dictate the color and size of vehicles.
(C) Control the price of fuel.
(D) Set permissible limits for air pollutants from

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(B) A proposed hydroelectric dam.
(C) A railway line project.
(D) A commercial tea plantation.

120. Consider the following statements regarding aspects of India's wildlife conservation efforts:
1. 'Project Tiger' was launched to protect the Bengal tiger.
2. 'Project Elephant' aims to conserve elephants and their corridors.
3. The GOI-UNDP project for sea turtles focuses on the Ganges dolphin.
4. 'Indo-Rhino Vision' aims to increase the population of the greater one-horned rhinoceros.
5. 'Crocodile Conservation' in India includes the Gharial.

Which of the statements given above are correct?
(A) 1, 2, 4, and 5
(B) 1, 3, 4, and 5
(C) 1, 2, 3, and 4
(D) 2, 3, 4, and 5

121. One of the principal aims of the National Mission for Sustainable Agriculture (NMSA) is to make Indian farming more resilient to:
(A) Climate change.
(B) International price fluctuations.
(C) Political instability.
(D) Pest attacks using traditional methods only.

122. Which of the following is NOT an international environmental issue?
(A) Biodiversity loss
(B) Climate change
(C) Acid rain
(D) Ozone layer depletion

123. The 'Swachha Bharat Abhiyan' aims to achieve a 'Clean India' and has two main components:
(A) Swachh Bharat Mission (Gramin/Rural) and Swachh Bharat Mission (Urban)
(B) Swachh Bharat Mission (Urban) and Swachh Bharat Mission (Forest)
(C) Swachh Bharat Mission (Rivers) and Swachh Bharat Mission (Air)
(D) Swachh Bharat Mission (Industrial) and Swachh Bharat Mission (Agricultural)

124. The development of a 'watershed' as a planning unit is beneficial for:
(A) Political administration.
(B) Census data collection.
(C) Delimitation of electoral constituencies.
(D) Integrated management of land and water resources.

125. Consider the following missions:
1. National Solar Mission
2. National Clean Air Programme
3. National Mission for a 'Green India'
4. National Bio-energy Mission

Which of the following represents the correct set of missions under the National Action Plan on Climate Change (NAPCC)?
(A) 1 and 2
(B) 1 and 3
(C) 2 and 4
(D) 3 and 4

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126. A GRIHA rating for a building signifies its level of:
(A) Structural safety and earthquake resistance.
(B) Environmental performance and sustainability.
(C) Financial viability and return on investment.
(D) Architectural beauty and aesthetic appeal.

127. Which city was the site of the 1984 gas leak disaster from a Union Carbide pesticide plant?
(A) Delhi
(B) Kanpur
(C) Bhopal
(D) Mumbai

128. Given below are two statements:
Statement I : Control of desertification involves practices that prevent land degradation in arid and semi-arid areas.
Statement II : Planting trees and managing grazing are effective methods to control desertification.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

129. The water sharing dispute concerning the Mahanadi river primarily involves which two states?
(A) Karnataka and Tamil Nadu
(B) Odisha and Chhattisgarh
(C) Punjab and Haryana
(D) Maharashtra and Gujarat

130. Consider the following statements about water conservation and management in India:
1. Rainwater harvesting is a method to collect and store rainwater.
2. The National Water Mission is part of the NAPCC.
3. Groundwater recharge helps to replenish aquifers.
4. The Yamuna Action Plan is focused on the conservation of wetlands.

Which of the statements given above are correct?
(A) 1, 2 and 3
(B) 2, 3 and 4
(C) 1 and 4 only
(D) 1, 2, 3 and 4

131. The primary focus of the 'National Mission for Enhanced Energy Efficiency' (NMEEE) is on:
(A) The solar power sector.
(B) The agricultural sector.
(C) The industrial, commercial, and residential sectors.
(D) The transport sector.

132. The term 'sustainability' in the context of climate change discussions most accurately means:
(A) Meeting current needs without compromising those of future generations.
(B) Maintaining economic growth regardless of the environmental impacts.
(C) Ensuring the continuous availability of fossil fuels for energy generation.
(D) Securing long-term business profitability in the competitive market.

133. Which of the following is a key objective of the 'National Mission for Sustaining the Himalayan Ecosystem'?
(A) To promote mining in the Himalayas.
(B) To build more roads for tourism.
(C) To relocate indigenous communities from the mountains.
(D) To understand the impacts of climate change on the Himalayan region.

134. Which environmental disaster highlighted the dangers of improperly stored chemical waste, leading to widespread health issues in a residential area?
(A) Minamata Disaster
(B) Love Canal Disaster
(C) Chernobyl Disaster
(D) Fukushima Disaster

135. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The 'Namami Gange' programme aims to clean and rejuvenate the River Ganga.
Reason (R) : The pollution of the Ganga is primarily caused by soil erosion along its banks.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

136. Which of the following is NOT a direct goal of the Swachha Bharat Abhiyan?
(A) Construction of household-owned and community-owned toilets.
(B) Providing subsidies for electric vehicles.
(C) Eradication of manual scavenging.
(D) Introduction of solid waste management mechanisms.

137. The Appiko movement in Karnataka was a grassroots movement to:
(A) Save the Western Ghats forests from being cut down.
(B) Protest against a nuclear power plant.
(C) Demand clean drinking water.
(D) Clean the beaches of the Karnataka coast.

138. Given below are two statements:
Statement I : Fluorosis is a disease caused by deficiency of fluoride in drinking water.
Statement II : Arsenocosis is a condition resulting from chronic exposure to high levels of arsenic.
(A) Both Statement I and Statement II are correct.

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(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

139. The most significant achievement of international efforts against ozone layer depletion was the:
(A) Kyoto Protocol.
(B) Paris Agreement.
(C) Ramsar Convention.
(D) Montreal Protocol.

140. Match List I with List II regarding environmental concepts and their associated mission or program.
List I: (Concept)
P. Green Building
Q. Vehicular Emissions
R. River Cleaning
S. Forest Conservation
List II: (Associated Mission/Program)
1. Namami Gange
2. National Mission for a 'Green India'
3. National Mission for Sustainable Habitat (GRIHA)
4. Bharat Stage Norms
Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

141. The main health concern related to Dengue is that it is a:
(A) Bacterial infection spread through contaminated food.
(B) Genetic disorder.
(C) Disease caused by mineral deficiency.
(D) Mosquito-borne viral infection.

142. The term 'food security' is closely linked to climate change because variations in climate can directly impact:
(A) The number of restaurants in a city.
(B) Agricultural productivity and crop yields.
(C) The nutritional value of processed foods.
(D) The import duties on luxury food items.

143. The 'National Action Plan on Climate Change' (NAPCC) provides a comprehensive framework for India's strategy to:
(A) Engage in international climate negotiations only.
(B) Control industrial pollution in major cities.
(C) Conserve endangered species exclusively.
(D) Address and mitigate the adverse impacts of climate change.

144. One of the main controversies associated with the Almatti Dam on the Krishna River is:
(A) The height of the dam and its effect on downstream water allocation.
(B) The structural instability and risk of collapse due to seismic activity.
(C) The submergence of cultural heritage sites and local historic monuments.
(D) The leakage of toxic chemicals used during the dam construction phase.

145. Consider the following environmental issues in India:
1. Soil erosion
2. Eutrophication of lakes
3. Desertification
4. Conservation of wetlands
5. Reclamation of degraded land
Which of the above statement(s) is/are correct regarding land and water degradation and conservation?
(A) 1, 2, and 3 only
(B) 1, 2, 3, 4, and 5
(C) 4 and 5 only
(D) 1, 3, and 5 only

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146. A Green Building as per the concept of Sustainable Habitat is one that:
(A) Optimizing use of energy, water, and building materials.
(B) Placing construction projects deep within local forests.
(C) Aesthetic certification by the municipal planning board.
(D) Using green pigments for the exterior walls of the structure.

147. Goitre is typically endemic in populations living in regions where the soil and water are deficient in:
(A) Iron

166. A key feature of the National Solar Mission is to promote solar energy through:
(A) The distribution of free solar panels to every citizen.
(B) The immediate closure of all coal-fired power plants.
(C) The mandatory installation of solar panels on all agricultural lands.
(D) A policy framework that encourages research, manufacturing, and deployment of solar technologies.

167. Which of the following is a direct impact of rising sea levels?
(A) Increased freshwater availability.
(B) Submergence of low-lying coastal areas and islands.
(C) Expansion of polar ice caps.
(D) Decrease in the frequency of tsunamis.

168. Given below are two statements:
Statement I : Carbon credits can be traded in a market.
Statement II : The purpose of carbon credits is to provide a financial incentive for reducing greenhouse gas emissions.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

169. What is the most common cause of Fluorosis in a population?
(A) Long-term ingestion of high concentrations of fluoride, usually through drinking water.
(B) Inhaling industrial fumes with high fluoride content.
(C) Consuming seafood from fluoride-contaminated waters.
(D) A genetic predisposition to fluoride accumulation.

170. Consider the following national missions under the National Action Plan on Climate Change (NAPCC):
1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission for Sustainable Habitat
4. National Water Mission
5. National Mission for Sustaining the Himalayan Ecosystem

Which of the statements given above are correct?
(A) 1, 2, and 3 only
(B) 1, 2, 3, and 4 only
(C) 1, 2, 3, 4, and 5
(D) 1 and 5 only

171. The restoration of lakes is a process aimed at reversing the effects of:
(A) Natural sedimentation over millennia.
(B) Seasonal water level fluctuations.
(C) Tectonic uplift.
(D) Eutrophication and pollution.

172. The Tehri Dam project on the Bhagirathi River has been controversial due to its location in a seismically active zone and:
(A) Its impact on marine life.
(B) The displacement of a large number of people.
(C) The use of foreign technology.
(D) Its proximity to an international border.

173. The Yamuna Action Plan (YAP) was launched with the primary objective of:
(A) Promoting tourism along the Yamuna river.
(B) Building a series of hydroelectric dams on the Yamuna.
(C) Intercepting and treating domestic wastewater entering the river.
(D) Developing inland navigation facilities.

174. Which of the following statements about Project Tiger is incorrect?
(A) It was launched to save the tiger from extinction.
(B) It aims to maintain a viable tiger population in their natural habitats.
(C) It involves the creation of tiger reserves.
(D) It is a program focused solely on captive breeding in zoos.

175. Arrange the following events in chronological order:
1. Launch of Project Tiger
2. Bhopal Gas Disaster
3. Launch of National Action Plan on Climate

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(B) Focus on cleanliness.
(C) Increase forest cover.
(D) Conserve water resources.

158. Given below are two statements:
Statement I : The Silent Valley movement was a successful effort to prevent a hydroelectric project in a pristine forest area in Kerala.
Statement II : The Appiko movement was an anti-mining protest in Odisha.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

159. The National Mission for a 'Green India' focuses on enhancing carbon sinks. This is primarily achieved through:
(A) Industrial carbon capture technologies.
(B) Ocean fertilization to promote phytoplankton growth.
(C) Banning the use of all fossil fuels.
(D) Afforestation and improving the quality of forest cover.

160. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : GRIHA is a rating tool that helps people assess the performance of their buildings against certain nationally acceptable benchmarks.
Reason (R) : It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

161. The 'People's Biodiversity Register' (PBR) is a tool for:
(A) Recording the number of tourists visiting a national park.
(B) Documenting local biological resources and traditional knowledge.
(C) Listing the owners of private forests.
(D) Registering patents for genetically modified organisms.

162. Vehicular emission norms in India like the 'Bharat Stage' standards are based on which international standards?
(A) American (EPA) standards
(B) Euro standards
(C) Japanese (JASO) standards
(D) Australian (ADR) standards

163. The primary concern in the Gandhamardhan hills protest in Odisha was:
(A) Deforestation for a steel plant.
(B) Displacement due to a large dam.
(C) Bauxite mining threatening a region rich in biodiversity and medicinal plants.
(D) Pollution from a thermal power plant.

164. The conservation of wetlands is considered important primarily because they:
(A) Provide critical habitats for a wide variety of species and offer vital ecosystem services.
(B) Are good sites for waste disposal.
(C) Are ideal locations for constructing large industrial parks.
(D) Can be easily converted into agricultural land.

165. Match List I with List II regarding environmental issues/projects and their locations.
List I: (Term)
P. Minamata Disaster
Q. Tehri Dam
R. Silent Valley
S. Appiko Movement
List II: (Associated Place/Project)
1. Uttarakhand
2. Karnataka
3. Japan
4. Kerala
Codes:
(A) P-3, Q-1, R-4, S-2
(B) P-3, Q-2, R-1, S-4
(C) P-4, Q-1, R-2, S-3
(D) P-2, Q-3, R-4, S-1

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(B) Fluoride
(C) Calcium
(D) Iodine

148. Given below are two statements:
Statement I : The Chipko movement was led by women who hugged trees to prevent them from being cut down.
Statement II : The movement originated in the state of Uttarakhand.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

149. Which of the following wildlife conservation projects specifically addresses a marine species?
(A) Project Tiger
(B) GOI-UNDP Sea Turtle project
(C) Project Elephant
(D) Indo-Rhino vision

150. A primary method for controlling desertification is:
(A) Increasing the cattle population for overgrazing.
(B) Removing all vegetation to prevent water loss.
(C) Diverting rivers to create new water bodies in arid zones.
(D) Afforestation and sustainable agricultural practices.

151. What is the fundamental goal of the National River Conservation Plan (NRCP)?
(A) To build dams on all major rivers for power generation.
(B) To improve the water quality of major rivers in the country.
(C) To promote river tourism and water sports.
(D) To link all rivers in India into a single national grid.

152. The Fukushima Daiichi nuclear disaster (2011) and the Chernobyl disaster (1986) are both examples of:
(A) Epidemics caused by poor sanitation.
(B) Disasters caused by the release of toxic industrial chemicals.
(C) Catastrophic accidents at nuclear power plants.
(D) Consequences of large-scale deforestation.

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153. 'Groundwater recharge' is the process by which:
(A) Groundwater is extracted for irrigation.
(B) Water moves downward from surface water to groundwater.
(C) Groundwater is purified using reverse osmosis.
(D) The level of the water table is measured.

154. Which mission under the NAPCC aims to make Indian agriculture less susceptible to the impacts of climate change through the development of climate-resilient crops and improved farming practices?
(A) National Mission for Sustainable Agriculture
(B) National Mission for a 'Green India'
(C) National Water Mission
(D) National Solar Mission

155. Consider the following water resource project controversies in India:
1. Narmada dam
2. Tehri dam
3. Almatti dam
4. Bhakra-Nangal dam
Which of the above statement(s) is/are correct?
(A) 1 and 2 only
(B) 1, 2 and 3
(C) 2, 3 and 4
(D) 1, 2, 3 and 4

156. The loss of biodiversity is a major global environmental issue because:
(A) It decreases the purely aesthetic value of wilderness areas for local tourism.
(B) It disrupts ecosystem services that are essential for long-term human well-being.
(C) It primarily impacts rare species within remote and isolated natural habitats.
(D) It disrupts ecosystem services that are essential for long-term human well-being.

157. The main objective of the Swachha Bharat Abhiyan is to achieve universal sanitation coverage and:
(A) Promote renewable energy.

Change (NAPCC)
4. Fukushima Daiichi Disaster

Select the correct answer from the codes given below:
(A) 1, 2, 3, 4
(B) 2, 1, 3, 4
(C) 1, 3, 2, 4
(D) 2, 3, 1, 4

176. Which of the following best describes the goal of 'watershed development'?
(A) To construct canals for irrigating large command areas.
(B) To conserve and manage soil and water resources within a natural drainage area.
(C) To divide a river basin for political and administrative purposes.
(D) To build recreational facilities like water parks.

177. The term Arsenocosis refers to the health condition arising from chronic poisoning by which element?
(A) Fluorine
(B) Arsenic
(C) Lead
(D) Mercury

178. Given below are two statements:
Statement I : The primary cause of ozone layer depletion is the increased concentration of CO2 in the atmosphere.
Statement II : Climate change is caused by the release of chlorofluorocarbons (CFCs).
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

179. The GRIHA rating system is an indigenous rating system developed for what purpose?
(A) To rate the quality of water in Indian rivers.
(B) To rank Indian states based on their forest cover.
(C) To assess the environmental performance of new buildings in India.
(D) To certify vehicles based on their emission levels.

180. Consider the following statements about epidemiological issues in India:
1. Fluorosis is caused by an excess of fluoride.
2. Goitre is linked to iodine deficiency.
3. Dengue is a water-borne bacterial disease.
4. Arsenocosis is caused by long-term exposure to arsenic.

Which of the statements given above are correct?
(A) 1, 2 and 3
(B) 1, 2 and 4
(C) 2, 3 and 4
(D) 1, 3 and 4

181. The conservation program Indo-Rhino Vision focuses on the:
(A) Greater One-horned Rhino
(B) Black Rhino
(C) Sumatran Rhino
(D) Javan Rhino

182. A major objective of the 'National Mission on Strategic Knowledge for Climate Change' is to:
(A) Implement afforestation projects directly.
(B) Form a data bank and knowledge-sharing platform on climate change.
(C) Provide subsidies for solar panel installation.
(D) Build climate-resilient urban infrastructure.

183. The Chipko Movement, a pivotal environmental movement, originated in which state?
(A) Kerala
(B) Karnataka
(C) Uttarakhand (then part of Uttar Pradesh)
(D) West Bengal

184. The 'National Water Mission' places a significant emphasis on increasing 'water use efficiency'. By what percentage does it aim to do so?
(A) 10%
(B) 30%
(C) 50%
(D) 20%

185. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The People's Biodiversity Register (PBR) is a mechanism for the formal documentation of local biodiversity.

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Reason (R) : The PBR has no legal standing and is used only for academic research.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

186. The concept of 'Carbon credits' is a market-based mechanism designed to:
(A) Increase the overall carbon emissions globally.
(B) Provide a financial incentive for reducing carbon emissions.
(C) Fund research into carbon-based life forms.
(D) Tax individuals based on their personal carbon footprint.

187. The GOI-UNDP Sea Turtle Project is particularly famous for its work in protecting the mass nesting sites of Olive Ridley turtles in which state?
(A) Tamil Nadu
(B) Kerala
(C) Goa
(D) Odisha

188. Given below are two statements:
Statement I : The 'Swachha Bharat Abhiyan' is primarily a forest conservation scheme.
Statement II : 'Namami Gange' is one of the eight missions under the National Action Plan on Climate Change.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

189. The 'Love Canal Disaster' is a well-known case of environmental pollution caused by:
(A) Improper disposal of toxic industrial waste.
(B) A nuclear accident.
(C) An oil tanker spill.
(D) A volcanic eruption.

190. Match List I with List II regarding National Missions of the NAPCC and their primary domains.
List I: (National Mission of NAPCC)
P. National Mission for Sustainable Agriculture
Q. National Mission for Sustaining the Himalayan Ecosystem
R. National Mission for Enhanced Energy Efficiency
S. National Solar Mission
List II: (Primary Domain)
1. Industry and Buildings
2. Renewable Energy
3. Farming and Food Security
4. Mountain Ecology
Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-1, S-2

191. Which of the following is an example of an effort to control desertification?
(A) Intensive mechanized farming.
(B) Unrestricted quarrying and mining.
(C) Rapid urbanization of arid lands.
(D) Building check dams and afforestation.

192. The main challenge addressed by the National River Conservation Plan is:
(A) Inter-state water disputes.
(B) Pollution abatement in rivers.
(C) Hydroelectric power generation.
(D) Flood management and control.

NODIA

193. The dispute related to the Almatti dam involves the sharing of water from which river?
(A) Cauvery
(B) Godavari
(C) Krishna
(D) Narmada

194. The concept of a 'Sustainable Habitat' involves all of the following EXCEPT:
(A) Promoting Green Buildings.
(B) Efficient management of solid and liquid waste.
(C) Improving energy efficiency in buildings.
(D) Encouraging the use of private transport over public transport.

195. Consider the following environmental conservation efforts in India:
1. Chipko Movement
2. Project Tiger
3. Namami Gange
4. Swachha Bharat Abhiyan
5. National Solar Mission

Which of the statements given above are correct?
(A) 1, 2, and 3
(B) 2, 3, 4, and 5
(C) 1, 2, 3, and 4
(D) All of the above

196. Which of the following best explains the relationship between climate change and food security?
(A) Climate change improves food security by increasing CO2 for plants.
(B) Climate change can disrupt agricultural production, leading to food shortages and price volatility.
(C) Food security is an economic issue unrelated to climate change.
(D) Climate change only affects the security of seafood.

197. Which of the following movements was a protest against a hydroelectric project in the fragile ecosystem of the Western Ghats in Kerala?
(A) Chipko Movement
(B) Silent Valley Movement
(C) Appiko Movement
(D) Gandhamardhan Movement

198. Given below are two statements:
Statement I : The primary purpose of a People's Biodiversity Register (PBR) is to facilitate bio-prospecting by multinational corporations.
Statement II : PBRs help in conserving biodiversity and ensuring benefit-sharing with local communities.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

199. The Crocodile Conservation Project in India was launched to protect the dwindling populations of its three native species, including the fish-eating:
(A) Mugger
(B) Saltwater Crocodile
(C) Caiman
(D) Gharial

200. The environmental issues related to the Narmada dam project included:
(A) Only air pollution from construction machinery.
(B) Only noise pollution affecting local wildlife.
(C) Contamination of the river with nuclear waste.
(D) Large-scale submergence of forests and displacement of tribal communities.

201. Which of the following is a key strategy for groundwater recharge?
(A) Paving all open ground to prevent evaporation.
(B) Building percolation tanks and check dams.
(C) Extracting groundwater at a faster rate.
(D) Discharging industrial effluents into the ground.

202. The Minamata disease, first discovered in Japan, is a neurological syndrome caused by severe:
(A) Lead poisoning
(B) Arsenic poisoning
(C) Cadmium poisoning
(D) Mercury poisoning

203. The primary goal of the National Mission for a 'Green India' is to:
(A) Increase the forest and tree cover and improve the quality of existing forests.
(B) Promote urban gardening.
(C) Mandate the use of green-colored building materials.
(D) Develop eco-tourism circuits.

204. Which of the following is NOT a global environmental issue?
(A) Climate change
(B) Biodiversity loss
(C) Localized soil pollution
(D) Ozone layer depletion

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205. Consider the following environmental movements in India:
1. Chipko Movement
2. Appiko Movement
3. Green Revolution
4. Silent Valley Movement

Which of the statements given above are correct?
(A) 1, 2 and 3
(B) 2, 3 and 4
(C) 1, 2 and 4
(D) 1, 3 and 4

206. 'Project Elephant' is a centrally sponsored scheme to:
(A) Capture and train elephants for circus shows.
(B) Promote the export of ivory.
(C) Establish elephant safari parks for tourism.
(D) Protect elephants, their habitat, and corridors.

207. Eutrophication in a water body is caused by:
(A) A lack of sunlight.
(B) Enrichment of water by nutrients like nitrates and phosphates.
(C) High concentration of toxins like mercury.
(D) An increase in the salinity of the water.

208. Given below are two statements:
Statement I : The Yamuna Action Plan is a bilateral project between India and Bangladesh.
Statement II : The main objective of the Yamuna Action Plan is to improve the water quality of the river.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

209. The GRIHA rating norms are an integral part of which National Mission under the NAPCC?
(A) National Mission for Sustainable Habitat
(B) National Solar Mission
(C) National Water Mission
(D) National Mission for a 'Green India'

210. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : The Bhopal Gas Tragedy was a catastrophic industrial accident.
Reason (R) : It was caused by the leakage of methyl isocyanate gas from a pesticide plant.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

211. Which of the following is a primary objective of the Swachha Bharat Abhiyan?
(A) To achieve 100% forest cover in India.
(B) To make India a global leader in solar power.
(C) To conserve the Himalayan ecosystem.
(D) To eliminate open defecation and improve solid waste management.

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212. The controversy surrounding many hydro-power projects in the Himalayan states of India is primarily due to:
(A) Their high cost compared to thermal power.
(B) The ecological fragility and seismic vulnerability of the region.
(C) The lack of technological expertise in India.
(D) The short lifespan of such projects.

213. The process of capturing atmospheric carbon dioxide and storing it in a stable form is known as:
(A) Carbon dating
(B) Carbonation
(C) Carbon sequestration
(D) Carbon trading

214. The National Mission for Enhanced Energy Efficiency (NMEEE) includes a market-based mechanism to enhance cost-effectiveness of improvements in energy efficiency. This is known as:
(A) Renewable Energy Certificate (REC)
(B) Energy Savers Certificate (ESC)
(C) Green Energy Bond (GEB)
(D) Perform, Achieve and Trade (PAT)

215. Match List I with List II regarding environmental disasters and their primary causes.

List I: (Disaster)
P. Chernobyl
Q. Minamata
R. Love Canal
S. Bhopal
List II: (Primary Cause)
1. Methylmercury poisoning
2. Methyl Isocyanate gas leak
3. Nuclear reactor explosion
4. Buried chemical waste
Codes:
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-4, S-3

216. The concept of People's Biodiversity Register is a mechanism to:
(A) Patent traditional knowledge for commercial use.
(B) Document local biodiversity and associated traditional knowledge.
(C) Create a list of people involved in biodiversity conservation.
(D) Register new species discovered by scientists.

217. In the context of the National Action Plan on Climate Change, what is the core focus of the National Mission for Sustainable Agriculture?
(A) Maximizing agricultural exports.
(B) Making agriculture more resilient to climate variability and change.
(C) Promoting large-scale corporate farming.
(D) Replacing all traditional crops with cash crops.

218. Given below are two statements:
Statement I : Desertification is the expansion of desert-like conditions, which can be caused by human activities.
Statement II : Overgrazing and deforestation are major causes of desertification.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

219. The term 'Green Building' refers to a building that is designed to be:
(A) Visually appealing with a lot of greenery around it.
(B) Constructed only with wood and other natural materials.
(C) Environmentally responsible and resource-efficient throughout its life-cycle.
(D) Exclusively for housing government environmental agencies.

220. Consider the following epidemiological issues:
1. Fluorosis
2. Arsenocosis
3. Goitre
4. Dengue
5. Minamata Disease
Which of the statements given above are correct regarding conditions linked to contamination or deficiencies in the environment?
(A) 1, 2 and 3 only
(B) 1, 2, 3 and 5
(C) 1, 2 and 4
(D) All of the above

221. The main reason for the 'Silent Valley' movement was to:
(A) Protect a pristine evergreen forest from a hydroelectric project.
(B) Protest against the felling of trees for a railway line.
(C) Oppose a mining project in the Western Ghats.
(D) Demand the declaration of Silent Valley as a tiger reserve.

222. The National River Conservation Plan (NRCP) grew out of which earlier plan?
(A) The Yamuna Action Plan
(B) The Narmada Action Plan
(C) The Cauvery Action Plan
(D) The Ganga Action Plan

223. The 1986 Chernobyl disaster is a prime example of which type of environmental disaster?
(A) Chemical spill
(B) Nuclear accident
(C) Biological hazard
(D) Natural disaster

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(D) aquifer management.

268. According to the passage, how does ground water recharge contribute to water conservation?
(A) By artificially increasing the amount of water seeping into aquifers.
(B) By preventing soil erosion and improving land productivity.
(C) By collecting runoff from parks and storing it in tanks.
(D) By managing the entire land and water resources of a drainage area.

269. Which of the following is mentioned as a method for facilitating ground water recharge?
(A) Constructing large storage tanks on rooftops.
(B) Implementing drip irrigation systems in agriculture.
(C) Building percolation pits and check dams.
(D) Planting trees to increase transpiration.

270. The passage suggests that the main purpose of water conservation techniques like watershed development and rainwater harvesting is to:
(A) exclusively serve industrial water needs.
(B) generate hydroelectric power from stored water.
(C) create recreational water bodies in urban areas.
(D) mitigate water scarcity and ensure long-term water security.

Direction : Please read the following source carefully.

The conservation of rivers and wetlands is a paramount environmental concern, addressed in India through targeted national plans and international conventions. The National River Conservation Plan (NRCP) is a significant government initiative aimed at improving the water quality of major rivers. Within this framework, specific action plans have been developed for critically polluted rivers, with the Yamuna Action Plan being a prominent example focusing on pollution abatement in one of the country's most important river systems. A more recent and comprehensive program, Namami Gange, has been launched for the rejuvenation of the river Ganga, integrating various efforts to clean the river and manage its ecosystem holistically. A related issue affecting water bodies, particularly lakes, is eutrophication—the process of nutrient enrichment, which leads to excessive growth of algae, depletion of oxygen, and degradation of water quality. Efforts are being made for the restoration of such lakes. Beyond rivers and lakes, the conservation of wetlands, which are vital ecosystems providing numerous ecological services, is crucial. India is a signatory to the Ramsar Convention, an international treaty for the conservation and wise use of wetlands. The designation of Ramsar sites across the country signifies a commitment to maintaining their ecological character and promoting their sustainable use.

Based on the above source, attempt the following five questions.

271. The Namami Gange and Yamuna Action Plan are part of a broader national effort primarily identified as the:
(A) Ramsar Convention.
(B) Wetland Restoration Program.
(C) National River Conservation Plan.
(D) Eutrophication Abatement Scheme.

272. What is eutrophication, as defined in the passage?
(A) The process of designating a wetland as a Ramsar site.
(B) The nutrient enrichment of a water body leading to degraded quality.
(C) A comprehensive program for the rejuvenation of the river Ganga.
(D) A pollution abatement plan specifically for the Yamuna river.

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273. The Ramsar Convention, to which India is a signatory, is an international treaty focused on the conservation of:
(A) major river systems.
(B) degraded lakes.
(C) national parks.
(D) wetlands.

274. The primary objective of the Namami Gange program is described as:
(A) the holistic rejuvenation and cleaning of the river Ganga.
(B) the designation of new Ramsar sites along the Ganga.

233. The Gandhamardhan hills in Odisha, site of an environmental movement, are considered a rich repository of:
(A) Bauxite and medicinal plants.
(B) Coal reserves.
(C) Iron ore.
(D) Mangrove forests.

234. Soil erosion can be most effectively controlled by:
(A) Removing all trees and vegetation from a slope.
(B) Using heavy machinery to level the land.
(C) Practicing intensive tillage and farming.
(D) Increasing vegetation cover and practicing contour ploughing.

235. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A) : International efforts, such as conventions and protocols, are necessary for protecting the global environment.
Reason (R) : Environmental issues like climate change and ozone depletion are transboundary and cannot be solved by any single nation alone.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

236. A key health impact of eutrophication in water bodies used for drinking water can be:
(A) Reduced incidence of waterborne diseases.
(B) The growth of toxic algal blooms that can harm humans.
(C) An improvement in the taste and odour of water.
(D) A decrease in the mineral content of water.

237. The 'Appiko' movement is culturally and philosophically linked to which other major environmental movement in India?
(A) Narmada Bachao Andolan
(B) Chipko Movement
(C) Silent Valley Movement
(D) Yamuna Action Plan

238. Given below are two statements:
Statement I : 'Energy security' means ensuring that a country has access to reliable and affordable energy.
Statement II : In the context of climate change, achieving energy security increasingly involves a shift towards renewable and low-carbon energy sources.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

239. The GOI-UNDP supported project for the conservation of sea turtles in India has a major focus on the state of Odisha because:
(A) It is the only state with a coastline.
(B) Sea turtles are found nowhere else in India.
(C) The UNDP headquarters is located there.
(D) It has the world's largest mass nesting beach for Olive Ridley turtles.

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240. Match List I with List II regarding environmental issues and their descriptions.
List I: (Issue)
P. Biodiversity Loss
Q. Ozone Layer Depletion
R. Sea Level Rise
S. Eutrophication
List II: (Description)
1. Inundation of coastal areas
2. Nutrient enrichment of water bodies
3. Reduction in the variety of species
4. Thinning of the stratospheric shield against UV radiation
Codes:
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-1, S-2

241. What is the main purpose of the Ramsar Convention?
(A) To regulate international trade in endangered species.
(B) To protect the Earth's ozone layer.
(C) To control transboundary movements of hazardous wastes.

(D) To promote the conservation and wise use of wetlands.

242. The National Mission on Strategic Knowledge for Climate Change aims to:
(A) Directly implement climate adaptation projects.
(B) Create a knowledge system to support policy-making and action on climate change.
(C) Fund international climate research collaborations exclusively.
(D) Provide climate change education in primary schools.

243. The 2011 Fukushima Daiichi nuclear disaster in Japan was a direct consequence of:
(A) A design flaw in the reactor.
(B) A human error during a routine check.
(C) A major earthquake and the subsequent tsunami.
(D) A cyber-attack on the plant's control systems.

244. A key difference between the Chipko and Appiko movements is their:
(A) Core ideology of non-violence.
(B) Primary goal of saving forests.
(C) Method of hugging trees.
(D) Geographical location.

245. Consider the following hydro-power or dam related environmental issues in India:
1. Narmada dam
2. Tehri dam
3. Almatti dam
4. Cauvery and Mahanadi river disputes
5. Hydro-power projects in Jammu & Kashmir

Which of the statements given above are correct?
(A) 1, 2, and 5 only
(B) 1, 2, 3, and 4 only
(C) 1, 2, 3, 4, and 5
(D) 4 and 5 only

246. The main objective of the National Mission for Sustainable Habitat is to:
(A) Promote sustainable agriculture.
(B) Make cities more sustainable through improvements in energy efficiency, waste management, and transport.
(C) Increase the forest cover of India.
(D) Develop new sources of renewable energy.

247. The term 'Indo-Rhino Vision' refers to a conservation program aimed at:
(A) Conserving all five species of rhinos globally.
(B) Increasing the population of the Greater One-horned Rhinoceros in Assam.
(C) Creating a virtual reality experience of rhinos in their habitat.
(D) A joint conservation effort between India and Indonesia for the Sumatran rhino.

248. Given below are two statements:
Statement I : Carbon sequestration involves the long-term storage of carbon dioxide to mitigate global warming.
Statement II : Planting trees is a form of natural carbon sequestration.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

249. The epidemiological issue of 'Arsenocosis' in India is most widespread in areas where drinking water is sourced from:
(A) Contaminated deep aquifers, especially in the Gangetic plain.
(B) Himalayan glacial melt.
(C) Desalinated seawater.
(D) Purified municipal tap water supplies.

250. The National Action Plan on Climate Change (NAPCC) is India's national-level strategy to:
(A) Comply with international trade regulations.
(B) Address the challenge of climate change through a set of defined missions.
(C) Focus exclusively on disaster management.
(D) Control population growth.

Direction : Please read the following source carefully.

Global environmental issues represent a complex and interconnected web of challenges that transcend national boundaries, necessitating international cooperation for effective mitigation. Prominent among these is biodiversity loss,

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a process accelerated by habitat destruction, pollution, and climate change, threatening ecosystem stability and the services they provide. Climate change itself, driven by anthropogenic greenhouse gas emissions, manifests through rising global temperatures, altered precipitation patterns, and an increased frequency of extreme weather events. A direct consequence of this is sea level rise, caused by the thermal expansion of seawater and the melting of glaciers and ice sheets, posing an existential threat to low-lying coastal areas and island nations. Another critical issue is ozone layer depletion, primarily caused by chlorofluorocarbons (CFCs) and other ozone-depleting substances. Although international efforts like the Montreal Protocol have been successful in curbing the production of these substances, the complete recovery of the ozone layer remains a long-term process. These global challenges have spurred a range of international efforts for environmental protection, including treaties, conventions, and intergovernmental panels aimed at fostering collective action, sharing scientific knowledge, and providing financial and technological support to developing nations to address these multifaceted environmental crises.

Based on the above source, attempt the following five questions.

251. Which of the following is identified as a direct consequence of both the thermal expansion of seawater and the melting of glaciers?
(A) Increased biodiversity loss
(B) Sea level rise
(C) Accelerated ozone layer depletion
(D) Intensified climate change

252. According to the passage, what is the primary driver of climate change?
(A) Anthropogenic greenhouse gas emissions
(B) The natural cycles of the Earth's climate system
(C) Depletion of the stratospheric ozone layer
(D) The thermal expansion of seawater

253. The success of the Montreal Protocol is primarily associated with addressing which environmental issue?
(A) Biodiversity loss
(B) Global climate change
(C) Ozone layer depletion
(D) Sea level rise

254. The passage implies that international efforts for environmental protection are necessary primarily because:
(A) developing nations lack the will to act independently.
(B) scientific knowledge is only available at the international level.
(C) developed nations are solely responsible for environmental degradation.
(D) environmental problems are often global in scope and cross national borders.

255. Which of the following is NOT mentioned in the passage as a cause of accelerated biodiversity loss?
(A) Habitat destruction
(B) Pollution
(C) The success of the Montreal Protocol
(D) Climate change

Direction : Please read the following source carefully.

India's National Action Plan on Climate Change (NAPCC) represents a comprehensive strategic framework designed to integrate climate change adaptation and mitigation imperatives into the national development process. Central to this framework are eight distinct National Missions, each targeting a specific area crucial for sustainable development. The National Solar Mission aims to establish India as a global leader in solar energy, while the National Mission for Enhanced Energy Efficiency focuses on fostering a market for energy-saving technologies and practices. Addressing urban sustainability, the National Mission for Sustainable Habitat promotes energy efficiency in buildings and improved waste management. Water security is the focus of the National Water Mission, which seeks to ensure equitable water distribution and conservation. The fragility of high-altitude ecosystems is addressed by the National Mission for Sustaining the Himalayan Ecosystem. Reforestation and ecological restoration are pursued through the National Mission for a 'Green India'. To safeguard food security, the National Mission for Sustainable Agriculture aims to make Indian agriculture more resilient to climate change. Finally, the National Mission

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intrinsic link between local livelihoods and forest ecosystems. Following a similar philosophy, the Appiko movement emerged in the Western Ghats of Karnataka, protesting against the felling of trees in tropical forests. In Kerala, the Silent Valley movement was a successful campaign to protect a pristine tract of tropical evergreen forest from being submerged by a proposed hydroelectric project, emphasizing the importance of preserving biodiversity hotspots. The Gandhamardhan movement in Odisha was another significant struggle, led by local communities, to prevent bauxite mining on the Gandhamardhan hills, which they held sacred and depended upon for medicinal plants and other resources. Complementing these movements, the concept of a People's Biodiversity Register (PBR) has been institutionalized as a tool for the formal documentation of local biodiversity, associated traditional knowledge, and its conservation practices, thereby empowering local communities in the management and sustainable use of biological resources.

Based on the above source, attempt the following five questions.

281. The Appiko movement, which occurred in the Western Ghats, was philosophically similar to which other conservation movement?
(A) The Chipko movement
(B) The Silent Valley movement
(C) The Gandhamardhan movement
(D) The Narmada Bachao Andolan

282. The primary objective of the Silent Valley movement was to:
(A) prevent bauxite mining on a sacred hill.
(B) save a tropical evergreen forest from a hydroelectric project.
(C) protest against the commercial felling of trees in Karnataka.
(D) document local biodiversity in a formal register.

283. What is the main purpose of a People's Biodiversity Register (PBR) as described in the passage?
(A) To lead protests against deforestation projects.
(B) To formally document local biodiversity and associated traditional knowledge.
(C) To demand government compensation for felled trees.
(D) To prevent the construction of hydroelectric projects.

284. The Gandhamardhan movement in Odisha was a community-led struggle primarily against which activity?
(A) The proposal for bauxite mining
(B) The construction of a large dam
(C) The felling of trees for timber
(D) The establishment of a new national park

285. A common theme among the Chipko, Appiko, Silent Valley, and Gandhamardhan movements is the:
(A) leadership by international environmental organizations.
(B) focus on documenting biodiversity through registers.
(C) active role of local communities in protecting their environment and livelihoods.
(D) exclusive use of legal challenges in high courts.

Direction : Please read the following source carefully.

India has initiated several targeted wild life conservation projects to protect its endangered and keystone species. 'Project Tiger', launched to save the national animal, has been a flagship program focusing on in-situ conservation by establishing a network of tiger reserves. This project addresses threats like poaching, habitat degradation, and human-wildlife conflict. Similarly, 'Project Elephant' was launched to ensure the long-term survival of the elephant population in their natural habitats by protecting the animals, their habitats, and their migratory corridors. For the conservation of reptilian species, the 'Crocodile Conservation Project' was initiated to save the three endangered crocodilian species found in India through captive breeding and subsequent release into the wild. In a collaborative effort for marine turtle conservation, the 'GOI-UNDP Sea Turtle Project' was implemented, focusing on protecting nesting sites and mitigating threats from fishing activities. A more recent and ambitious initiative is the 'Indo-Rhino Vision', a partnership aimed at increasing the population of the Indian one-horned rhinoceros and

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(A) impact on interstate water sharing.
(B) contribution to river eutrophication.
(C) role in the Narmada dam controversy.
(D) location in a seismically active region.

262. The environmental issues related to the Almatti, Cauvery, and Mahanadi projects primarily revolve around:
(A) displacement of indigenous communities.
(B) disputes over interstate water sharing.
(C) risks associated with seismic activity.
(D) submergence of vast forest areas.

263. What is the central dilemma associated with hydro-power projects in Jammu & Kashmir, Himachal, and the North-Eastern States as described in the passage?
(A) The lack of technological expertise to build such projects in mountainous regions.
(B) The dispute between central and state governments over project ownership.
(C) The conflict between providing clean energy and incurring significant environmental trade-offs.
(D) The financial non-viability of such projects compared to thermal power.

264. The passage cites the Narmada dam project as an example of a water resource project leading to:
(A) successful interstate water dispute resolution.
(B) the promotion of clean energy without environmental impact.
(C) a model for sustainable hydropower development.
(D) controversies related to community displacement and submergence of forests.

265. Based on the passage, what is a common thread linking the environmental issues of the Narmada, Tehri, and various North-Eastern hydro-power projects?
(A) They all highlight the tension between development goals and environmental/ social costs.
(B) They are all primarily focused on resolving interstate water disputes.
(C) They have all been successfully completed without any environmental protests.
(D) They are exclusively located in seismically inactive zones.

Direction : Please read the following source carefully.

Water conservation is a critical component of environmental management, particularly in a country with high variability in rainfall and increasing water demand. A key strategy in this domain is the development of watersheds, which involves managing land and water resources within a specific drainage area to conserve moisture, prevent soil erosion, and improve water availability. This holistic approach integrates soil and water conservation measures to enhance the overall productivity of the land. Another vital technique is rainwater harvesting, the process of collecting and storing rainwater that runs off from rooftops, parks, and other surfaces, rather than allowing it to run off and be lost. This collected water can be stored in tanks or used for various domestic and agricultural purposes. Closely related to this is the practice of ground water recharge, which artificially augments the amount of water that seeps into the ground to replenish aquifers. Methods for ground water recharge include constructing percolation pits, trenches, and check dams that slow down the flow of surface water, giving it more time to infiltrate into the soil. These practices are not only crucial for mitigating water scarcity but also for maintaining the ecological balance and ensuring long-term water security.

Based on the above source, attempt the following five questions.

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266. What is the primary principle behind watershed development as described in the passage?
(A) The exclusive focus on constructing large dams to store river water.
(B) The integrated management of land and water resources within a drainage basin.
(C) The collection and storage of rainwater exclusively from rooftops.
(D) The artificial pumping of water into deep underground aquifers.

267. The practice of collecting and storing rainwater from surfaces like rooftops is known as:
(A) watershed development.
(B) rainwater harvesting.
(C) ground water recharge.

224. Which of the following is a key strategy for the conservation of wetlands?
(A) Designating them as Ramsar sites.
(B) Draining them for agriculture.
(C) Using them for landfill.
(D) Converting them into residential areas.

225. Arrange the following government initiatives/ projects in the chronological order of their launch year:
1. Project Elephant
2. Swachha Bharat Abhiyan
3. National Action Plan on Climate Change (NAPCC)
4. Project Tiger

Select the correct answer from the codes given below:
(A) 4, 1, 3, 2
(B) 1, 4, 3, 2
(C) 4, 1, 2, 3
(D) 1, 4, 2, 3

226. What does the term 'adaptability' signify in the context of climate change?
(A) The process of reducing greenhouse gas emissions.
(B) The ability of human and natural systems to cope with or adjust to climate change.
(C) The financial cost associated with climate change impacts.
(D) The complete prevention of any change in the climate system.

227. The Ganga Action Plan and the Yamuna Action Plan fall under the umbrella of the:
(A) National Water Mission
(B) National Mission for Sustainable Habitat
(C) National River Conservation Plan
(D) National Mission for a 'Green India'

228. Given below are two statements:
Statement I : The eight missions of the NAPCC are independent of each other and have no overlapping objectives.
Statement II : The National Solar Mission and the National Mission for Enhanced Energy Efficiency both contribute to India's climate change mitigation goals.
(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect.
(C) Statement I is correct but Statement II is incorrect.
(D) Statement I is incorrect but Statement II is correct.

229. The reclamation of degraded land is crucial for:
(A) Expanding urban areas.
(B) Building more industrial sites.
(C) Creating large water storage reservoirs.
(D) Restoring ecosystem services and improving agricultural productivity.

230. Consider the following statements related to vehicular emissions in India:
1. India has a system of vehicular emission norms known as Bharat Stage Emission Standards (BSES).
2. These norms are aimed at reducing the output of air pollutants from internal combustion engines.
3. The norms are progressively made more stringent.
4. These norms only apply to commercial vehicles, not private cars.

Which of the statements given above are correct?
(A) 1 and 2 only
(B) 1, 2 and 3
(C) 2, 3 and 4
(D) 1, 3 and 4

231. The primary aim of the 'Namami Gange' program is:
(A) To link the Ganga with other rivers.
(B) To achieve pollution abatement and rejuvenation of the Ganga river.
(C) To promote inland water transport.
(D) To build a series of dams on the Ganga for irrigation.

232. Which of the following is NOT a mission under the National Action Plan on Climate Change (NAPCC)?
(A) National Mission on Strategic Knowledge for Climate Change
(B) National Mission for Sustainable Agriculture
(C) National Mission on Biodiversity and Human Well-being
(D) National Mission for Sustaining the Himalayan Ecosystem

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(C) the promotion of hydroelectric projects on the river.
(D) a specific action plan focused solely on industrial pollution.

275. According to the passage, an immediate consequence of eutrophication in a lake is:
(A) increased water clarity and purity.
(B) improved conditions for fish survival.
(C) excessive growth of algae and depletion of oxygen.
(D) its designation as a Ramsar site.

Direction : Please read the following source carefully.

Land degradation is a severe environmental challenge, with soil erosion and desertification being its most critical manifestations. Soil erosion, the process by which the topsoil is detached and transported by agents like water and wind, leads to a loss of fertility and reduces the land's agricultural productivity. Various measures are employed for the reclamation of degraded land, aiming to restore its ecological functionality and productive capacity. This can involve techniques like afforestation, creating shelterbelts, and stabilizing sand dunes. Desertification is a more extreme form of land degradation in arid, semi-arid, and dry sub-humid areas, resulting from various factors including climatic variations and human activities. Its control is a global imperative, involving sustainable land management practices, water resource management, and protecting vegetative cover. In the context of adapting to and mitigating these issues, the concept of sustainability is paramount. Climate change further exacerbates these problems, making adaptability a key concern. Strategies must address the interconnected challenges of ensuring energy security, food security, and overall sustainability. This requires a multi-pronged approach that links land reclamation and desertification control with broader goals of climate resilience and secure access to food and energy resources for the population.

Based on the above source, attempt the following five questions.

276. According to the passage, desertification is defined as an extreme form of land degradation occurring specifically in which type of areas?
(A) In arid, semi-arid, and dry sub-humid areas
(B) Only in coastal and marshy lands
(C) Exclusively in tropical rainforests
(D) In permanently frozen polar regions

277. Which of the following is described as a technique for the reclamation of degraded land?
(A) Promoting monoculture agriculture
(B) Increasing industrial emissions
(C) Urban expansion into fertile lands
(D) Afforestation and stabilizing sand dunes

278. The passage identifies soil erosion as the process where topsoil is detached and transported primarily by:
(A) solar radiation and temperature changes.
(B) agents like water and wind.
(C) human and animal foot traffic.
(D) chemical reactions within the soil.

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279. The passage suggests that climate change affects land degradation by:
(A) making desertification and erosion less severe.
(B) having no significant impact on soil conditions.
(C) exacerbating the problems and making adaptability a key concern.
(D) exclusively causing desertification while halting erosion.

280. The text links the control of desertification and land reclamation with the broader goals of:
(A) industrial development and urbanisation.
(B) short-term economic profits from land use.
(C) promoting international tourism in arid zones.
(D) energy security, food security, and sustainability.

Direction : Please read the following source carefully.

Community participation and grassroots movements have played a pivotal role in forest conservation in India, often emerging in response to threats from deforestation and commercial exploitation. The Chipko movement, originating in the Himalayan region, became internationally famous for its strategy of villagers, particularly women, hugging trees to prevent them from being felled. This movement highlighted the

on Strategic Knowledge for Climate Change is dedicated to building a robust knowledge system that informs policy-making and fosters research and development in climate science, ensuring a scientifically grounded approach to tackling this multifaceted challenge.

Based on the above source, attempt the following five questions.

256. Which National Mission under the NAPCC is specifically dedicated to improving the scientific understanding and data required for effective climate policy?
(A) National Mission for Sustainable Agriculture
(B) National Mission on Strategic Knowledge for Climate Change
(C) National Mission for Enhanced Energy Efficiency
(D) National Mission for Sustaining the Himalayan Ecosystem

257. According to the passage, the objective of making Indian agriculture more resilient to climate change falls under which mission?
(A) National Water Mission
(B) National Mission for a 'Green India'
(C) National Solar Mission
(D) National Mission for Sustainable Agriculture

258. The National Mission for Sustainable Habitat is primarily concerned with which of the following areas?
(A) Urban planning, energy efficiency in buildings, and waste management
(B) Reforestation and afforestation projects
(C) Conservation of high-altitude ecosystems
(D) Promoting the market for energy-saving technologies across all sectors

259. Which of the following pairs of missions and their objectives is correctly matched?
(A) National Solar Mission – Ensuring equitable water distribution
(B) National Water Mission – Promoting energy efficiency in buildings
(C) National Mission for a 'Green India' – Reforestation and ecological restoration
(D) National Mission for Enhanced Energy Efficiency – Sustaining the Himalayan Ecosystem

260. The overarching goal of the National Action Plan on Climate Change (NAPCC), as described in the passage, is to:
(A) integrate climate adaptation and mitigation into the national development strategy.
(B) focus exclusively on mitigation by reducing greenhouse gas emissions.
(C) prioritize economic growth over environmental concerns.
(D) replace all fossil fuels with solar energy immediately.

Direction : Please read the following source carefully.

Environmental issues in India are often deeply intertwined with developmental projects, particularly large-scale water resource infrastructure. The Narmada dam project has been a focal point of significant social and environmental controversy, raising concerns about the displacement of communities and the submergence of forests and agricultural land. Similarly, the Tehri dam in the Himalayas has faced criticism regarding its location in a seismically active zone and the potential for large-scale disaster, alongside issues of resettlement and ecological impact. In the southern part of the country, the Almatti dam has been a source of interstate water-sharing disputes, while water allocation from the Cauvery and Mahanadi rivers continues to be a contentious issue between riparian states. Beyond dams, the development of hydro-power projects in ecologically sensitive regions like Jammu & Kashmir, Himachal Pradesh, and the North-Eastern States presents a complex dilemma. While these projects are promoted for their potential to provide clean energy, their construction often involves significant environmental trade-offs, including disruption of riverine ecosystems, deforestation, and impacts on local biodiversity. These cases highlight the persistent challenge of balancing national development priorities, such as water and energy security, with the imperative of environmental protection and social equity.

Based on the above source, attempt the following five questions.

261. According to the passage, a primary environmental concern associated with the Tehri dam is its:

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distributing them across multiple protected areas in Assam to ensure their long-term viability. These species-specific projects are critical components of India's broader biodiversity conservation strategy, aiming to secure the future of its most iconic wildlife.

Based on the above source, attempt the following five questions.

286. Which project was specifically launched to ensure the long-term survival of elephant populations by protecting their habitats and migratory corridors?
(A) Project Tiger
(B) Indo-Rhino Vision
(C) GOI-UNDP Sea Turtle Project
(D) Project Elephant

287. The 'Indo-Rhino Vision' program has the primary objective of:
(A) conserving all three species of crocodiles in India.
(B) protecting the nesting sites of marine turtles.
(C) increasing the rhino population and distributing them across protected areas.
(D) establishing tiger reserves to address poaching.

288. The conservation strategy employed by the 'Crocodile Conservation Project' primarily involves:
(A) protecting migratory corridors between reserves.
(B) captive breeding and subsequent release into the wild.
(C) establishing a network of in-situ reserves.
(D) collaborating with the UNDP on marine conservation.

289. The 'GOI-UNDP Sea Turtle Project' is an example of a collaborative effort focused on:
(A) saving the Indian one-horned rhinoceros.
(B) captive breeding of endangered reptilian species.
(C) ensuring the long-term survival of the tiger.
(D) the conservation of marine turtles and their nesting sites.

290. Based on the passage, what is a common feature of both 'Project Tiger' and 'Project Elephant'?
(A) They both focus on in-situ conservation by protecting natural habitats.
(B) They both rely primarily on captive breeding programs.
(C) They are both collaborative projects with the UNDP.
(D) They are both targeted at conserving marine species.

Direction : Please read the following source carefully.

Mitigating climate change and promoting urban sustainability involve a combination of technological and policy-driven strategies. Carbon sequestration, the process of capturing and storing atmospheric carbon dioxide, is a key strategy to reduce the amount of CO2 in the atmosphere. This can be achieved through natural means like afforestation or through technological methods. The concept of carbon credits is a market-based mechanism designed to incentivize emission reductions. A carbon credit represents the right to emit one tonne of carbon dioxide, and entities that reduce their emissions below a set cap can sell their surplus credits to those who exceed their limits, thus creating a financial incentive for decarbonization. In the realm of urban development, the idea of a Sustainable Habitat is gaining prominence. This is exemplified by the push for Green Buildings, which are designed to be environmentally responsible and resource-efficient throughout their life cycle. In India, the GRIHA (Green Rating for Integrated Habitat Assessment) Rating Norms provide a framework for evaluating the environmental performance of buildings. Another critical area for urban environmental management is transport. To address vehicular pollution, India has progressively tightened its Vehicular emission norms, moving towards stricter standards to control pollutants like NOx, SOx, and particulate matter, thereby improving urban air quality.

Based on the above source, attempt the following five questions.

291. What is the primary function of carbon credits as described in the passage?
(A) To provide a direct government subsidy for planting trees.
(B) To serve as a rating system for the environmental performance of buildings.
(C) To act as a market-based mechanism that

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ANSWERS

1. (B) Biodiversity loss
The reduction in the variety of life forms within a specific ecosystem or across the entire planet is a significant environmental challenge. This phenomenon occurs when species vanish at rates exceeding natural extinction. Maintaining diverse biological systems is essential for ecosystem services like pollination and climate regulation. Human activities, including habitat destruction and overexploitation, primarily drive this decline, threatening the long-term stability of the global biosphere.

2. (A) To unlock energy efficiency markets through innovative policy and regulatory regimes.
This specific mission aims to create market-based mechanisms and regulatory frameworks that encourage efficient energy consumption. It targets sectors like industry and power generation to reduce overall energy intensity. By unlocking investments and promoting innovation, the initiative helps mitigate climate change while ensuring national energy security. These measures include trading energy savings certificates and setting performance standards for energy-intensive enterprises to achieve sustainable growth goals.

3. (C) Statement I is correct but Statement II is incorrect.
Nutrient enrichment in water bodies causes excessive algal growth, which initially seems beneficial but ultimately harms the ecosystem. As these algae die and decompose, they consume vast amounts of dissolved oxygen. This depletion creates hypoxic conditions that lead to mass mortality among fish and other aquatic organisms. Consequently, the overall water quality deteriorates significantly, disrupting the natural balance of the aquatic habitat and biodiversity for all life forms.

4. (D) Protecting trees and forests from being felled.
The social-ecological initiative began in the Himalayan region as a non-violent protest against deforestation. Local communities, particularly women, embraced trees to prevent contractors from felling them for commercial purposes. This movement highlighted the vital link between forest conservation and the livelihoods of rural populations. It significantly influenced future environmental policies in the country by emphasizing community participation in protecting natural resources and maintaining the delicate ecological balance.

5. (B) 2 and 4 only
Global environmental protection initiatives address complex transboundary issues such as the thinning of the protective atmospheric layer and biodiversity decline. These efforts rely on multilateral treaties and conventions signed by numerous nations to establish shared responsibilities. While many modern agreements exist, the movement began decades ago rather than recently. Such cooperation is essential for managing problems that extend beyond national borders and require collective action to protect the biosphere.

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6. (B) Inter-linking of rivers
Various techniques exist for managing water resources, such as capturing rainfall and replenishing underground aquifers. However, connecting major river systems primarily focuses on redistributing water between surplus and deficit basins on a large scale. While this might improve distribution, it is considered an engineering-heavy intervention rather than a direct conservation method. True conservation emphasizes reducing wastage, enhancing local storage, and improving the efficiency of existing water use to ensure long-term sustainability.

7. (D) Large-scale displacement of people and submergence of forests.
Large-scale infrastructure projects on river systems often face significant opposition due to their immense socio-environmental impacts. The construction of the dam led to the inundation of vast forest tracts and fertile agricultural lands. Furthermore, the project necessitated the relocation of thousands of tribal families from their ancestral homes, sparking debates over

waste dump.

298. The passage links the incidence of Dengue to which environmental factor?
(A) Excessive fluoride in groundwater.
(B) Inadequate water storage creating mosquito breeding grounds.
(C) Iodine deficiency in the soil.
(D) Radiological contamination from nuclear accidents.

299. Which pair of disasters mentioned in the passage are specifically identified as nuclear or radiological incidents?
(A) Love Canal and Bhopal Gas Disaster
(B) Chernobyl and Fukushima Daiichi
(C) Minamata and Love Canal
(D) Bhopal Gas Disaster and Chernobyl

300. According to the text, Fluorosis is a health condition affecting bones and teeth that results from:
(A) excessive intake of fluoride.
(B) exposure to toxic industrial gas.
(C) prolonged intake of arsenic.
(D) bites from infected mosquitoes.

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incentivizes emission reductions.
(D) To set mandatory emission limits for all vehicles in India.

292. The GRIHA Rating Norms in India are used for which purpose?
(A) Evaluating the environmental performance of buildings.
(B) Setting emission standards for industrial factories.
(C) Regulating the sale and purchase of carbon credits.
(D) Managing the process of technological carbon sequestration.

293. According to the passage, tightening Vehicular emission norms in India is a policy measure primarily aimed at:
(A) promoting the use of public transportation.
(B) reducing the number of vehicles on the road.
(C) incentivizing the development of green buildings.
(D) controlling pollutants and improving urban air quality.

294. Carbon sequestration is defined as the process of:
(A) creating a market for trading emission rights.
(B) capturing and storing atmospheric carbon dioxide.
(C) designing environmentally responsible buildings.
(D) establishing stricter emission norms for vehicles.

295. The concept of Sustainable Habitat, as exemplified by Green Buildings and GRIHA, focuses on:
(A) reducing emissions from the transport sector exclusively.
(B) creating financial incentives for emission reductions.
(C) promoting resource efficiency and environmental responsibility in the built environment.
(D) capturing and storing carbon dioxide from power plants.

Direction : Please read the following source carefully.

Environmental degradation and pollution can lead to severe public health consequences, often manifesting as specific epidemiological issues in affected populations. Certain diseases are strongly linked to the presence of specific environmental contaminants. Fluorosis, a debilitating condition affecting teeth and bones, is caused by the excessive intake of fluoride, often through contaminated groundwater. Similarly, Arsenocosis is a chronic illness resulting from prolonged exposure to arsenic, another common and dangerous groundwater contaminant in several regions. Goitre, characterized by the swelling of the thyroid gland, is typically associated with iodine deficiency, which can be an environmental issue in soils and water of certain geographical areas. Vector-borne diseases like Dengue are also critical environmental health issues, linked to inadequate water storage and sanitation practices that create breeding grounds for mosquitoes. Beyond these chronic issues, acute environmental disasters have caused catastrophic health crises. The Minamata disaster was a case of mass mercury poisoning in Japan. The Love Canal disaster in the USA highlighted the dangers of chemical waste dumps. The 1984 Bhopal Gas Disaster in India remains one of the world's worst industrial accidents, and the 1986 Chernobyl Disaster and the 2011 Fukushima Daiichi nuclear disaster are stark reminders of the profound and long-lasting health impacts of radiological contamination.

Based on the above source, attempt the following five questions.

296. Which of the following epidemiological issues is caused by chronic exposure to arsenic in drinking water?
(A) Goitre
(B) Dengue
(C) Fluorosis
(D) Arsenocosis

297. The Minamata disaster, according to the passage, was a catastrophic event involving:
(A) mass poisoning from mercury contamination.
(B) a major nuclear reactor meltdown.
(C) the leakage of toxic gas from a pesticide plant.
(D) the seepage of chemicals from an industrial

human rights and environmental justice. These issues highlighted the conflict between pursuing industrial development and protecting the ecological integrity of rural regions.

8. (A) Green Rating for Integrated Habitat Assessment
The national framework provides a standardized system for evaluating the environmental impact of construction projects throughout their entire life cycle. It helps developers and architects reduce energy consumption, minimize waste, and utilize sustainable materials effectively. By following these guidelines, buildings can achieve higher efficiency and lower carbon footprints. This rating system is essential for promoting sustainable urban development and meeting national climate goals while reducing the overall ecological impact of the built environment.

9. (C) The leakage of buried industrial chemical waste.
A significant environmental health crisis occurred when toxic chemical waste buried underground began leaking into a residential neighborhood. The site, originally used by a chemical company, was later developed for housing and schools, leading to serious medical conditions among local residents. This tragedy became a catalyst for stricter federal laws regarding hazardous waste disposal. It emphasized the long-term dangers of industrial pollution and the urgent need for rigorous land-use regulations to protect public safety.

10. (A) Both A and R are true and R is the correct explanation of A.
National climate strategies often incorporate initiatives to expand and improve ecological infrastructure. Increasing tree cover and restoring degraded forests are vital for capturing atmospheric carbon and enhancing biodiversity. These efforts also provide natural buffers against extreme weather events and support the livelihoods of forest-dependent communities. By integrating these goals into a broader action plan, the country aims to achieve its mitigation targets while ensuring ecological stability and building resilience against environmental changes.

11. (D) Fluorosis
Prolonged ingestion of high levels of fluoride, predominantly through contaminated drinking water, leads to a serious medical condition. This issue affects various parts of the body, causing dental discoloration and severe skeletal deformities in chronic cases. It is a significant public health concern in regions where groundwater naturally contains elevated mineral concentrations. Effective management requires providing safe water alternatives and implementing rigorous filtration techniques for local communities to prevent the long-term debilitating effects.

12. (B) Ganga
The comprehensive conservation initiative focuses on cleaning and rejuvenating one of the most culturally and ecologically significant river systems. It employs diverse strategies, including sewage treatment, biodiversity protection, and public awareness campaigns, to restore the river's health. By addressing pollution from industrial and domestic sources, the mission aims to ensure sustainable water quality. This effort is crucial for protecting the health of millions of people who depend on the river and its ecosystems.

13. (C) A tradable permit representing the right to emit one tonne of carbon dioxide.
The mechanism functions as a tradable permit that grants the holder the right to release a specific amount of carbon dioxide or other greenhouse gases. One credit typically represents the reduction or avoidance of one metric tonne of carbon dioxide. By putting a price on emissions, this system encourages industries to adopt cleaner technologies and reduce their overall environmental impact. It facilitates global efforts to meet climate targets through flexible and market-oriented solutions.

14. (D) A hydro-power project
An environmental campaign in the Western Ghats aimed to protect a tropical evergreen forest from being submerged by a proposed power generation facility. The region is known for its incredible biodiversity, including rare species found nowhere else. Protesters successfully argued that the ecological value of the pristine forest far outweighed the benefits of the project. This victory established a major precedent for prioritizing ecological conservation in national

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on transportation and the other on the built environment for sustainability.

29. (B) Karnataka, Andhra Pradesh, and Maharashtra
The dispute over water allocation from a major dam on the Krishna River involves several neighboring states. Tensions often arise concerning the height of the reservoir and the volume of water released to downstream regions. Legal and political negotiations between various states have been ongoing to find an equitable solution. These conflicts highlight the challenges of managing shared river basins where agricultural and industrial demands frequently exceed the available supply in an increasingly water-stressed environment.

30. (A) 1 and 2 only
The mission aims to transform the agricultural sector by enhancing its ability to withstand climatic shifts. It focuses on improving food security through the adoption of sustainable farming techniques and efficient resource management. By promoting soil health and moisture conservation, the initiative helps farmers maintain productivity despite unpredictable weather patterns. Contrary to reducing the workforce or mandating exports, the strategy prioritizes making existing livelihoods more resilient and environmentally sustainable for the long term for the farming community.

31. (D) Saltwater crocodile, Mugger, and Gharial
Conservation initiatives were established to protect the three distinct types of large reptiles native to the region. These include the long-snouted, fish-eating variety, the widespread freshwater marsh inhabitant, and the larger species found in tidal environments. Programs focus on captive breeding and releasing these animals into protected sanctuaries to prevent their extinction. This comprehensive approach addresses the specific habitat needs of each species while managing the potential for conflict between humans and wildlife in shared landscapes.

32. (A) Restoring damaged or degraded land to a functional, usable state.
The process involves restoring damaged or unproductive land to a functional state suitable for ecological or economic use. This can include rehabilitating old mining sites, stabilizing eroded slopes, or treating soil affected by high salinity. Various techniques like afforestation and nutrient management are employed to improve soil quality and biodiversity. Successful restoration helps mitigate the loss of arable land and enhances the overall resilience of the landscape against environmental degradation and unsustainable land-use practices.

33. (B) A structure designed and operated to minimize negative environmental impact.
A structure designed with high environmental standards aims to minimize its overall footprint throughout its entire lifespan. This involves optimizing energy and water usage, incorporating sustainable materials, and reducing waste during construction and operation. Such buildings often utilize natural lighting and ventilation to lower maintenance costs and improve indoor air quality. By following these principles, the built environment can contribute significantly to national sustainability goals and help combat the effects of climate change through efficient design.

34. (C) Pollution in the Yamuna River.
A dedicated conservation program was launched to tackle the severe degradation of a major river flowing through several industrial and urban hubs. The initiative focuses on installing sewage treatment plants, intercepting wastewater drains, and improving sanitation along the riverbanks. By reducing the direct discharge of pollutants, the plan seeks to restore water quality to acceptable levels. This effort is essential for protecting the health of millions who rely on the river's resources and maintaining aquatic biological diversity.

35. (A) Both A and R are true and R is the correct explanation of A.
The initiative seeks to enhance the efficiency of water usage across all sectors by promoting conservation and minimizing wastage. This goal is critical because changing climatic conditions are likely to increase the frequency and severity of droughts. By improving the way water is managed, the mission helps ensure a more reliable supply for agriculture and industry. This proactive approach is essential for building national resilience against the anticipated

NODIA

drought on communities and agricultural productivity in vulnerable regions.

22. (B) Transforming fertile land into desert through drought and deforestation.
Fertile regions can transform into arid landscapes through a combination of climatic variations and human activities. Factors like prolonged drought, unsustainable farming practices, and the removal of forest cover strip the land of its productive capacity. This degradation makes the soil vulnerable to erosion and reduces its ability to support plant life. Addressing this issue requires integrated land management, reforestation, and the implementation of sustainable agricultural techniques to restore the ecological balance and soil health.

23. (D) Karnataka
A grassroots forest conservation movement emerged in the southern state of Karnataka, drawing inspiration from similar Himalayan initiatives. Local villagers hugged trees to prevent them from being felled by commercial interests, emphasizing the importance of preserving the Western Ghats ecosystem. The movement focused on protecting existing forests, planting new saplings, and promoting the rational use of forest resources. It remains a significant example of local community action against environmental degradation and for the protection of biological diversity.

24. (A) To establish India as a global leader in solar energy.
The initiative seeks to establish the country as a global leader in renewable energy by rapidly expanding generating capacity. It provides a policy framework to promote the manufacturing and deployment of solar technology across various sectors. By reducing dependence on fossil fuels, the mission aims to achieve energy security while mitigating carbon emissions. This strategy involves large-scale solar parks, rooftop installations, and research to make clean energy more affordable and accessible to all citizens.

25. (2, 3, 1, 4)
The historical timeline of major environmental crises reflects the evolving risks of industrial and nuclear development. Early tragedies involving heavy metal poisoning were followed by catastrophic chemical leaks in industrial cities. Shortly thereafter, a major nuclear accident occurred, highlighting the dangers of power facility failures. In the current century, a natural disaster triggered another significant nuclear crisis. Mapping these events helps researchers understand the long-term consequences of human activities on global health and environmental stability.

26. (A) The Biodiversity Management Committee (BMC)
A comprehensive document is maintained at the local level to record various biological resources and traditional knowledge. The primary responsibility for managing this register lies with a committee established at the village or municipal level. This decentralized approach ensures that local communities retain control over their natural heritage and receive fair benefits from its use. It is a vital tool for conservation planning and protecting indigenous intellectual property under national biodiversity laws for sustainable development.

27. (D) Wetlands
The international treaty focuses specifically on the conservation and sustainable management of wetlands around the world. These ecosystems, which include marshes, swamps, and peatlands, provide essential services like water filtration and flood control. The agreement encourages nations to designate sites of international importance to ensure their long-term protection. By fostering global cooperation, the convention helps safeguard critical habitats for migratory birds and various other species that depend on these unique and fragile environments for their survival.

28. (C) Statement I is correct but Statement II is incorrect.
National authorities implement strict standards to limit the release of harmful pollutants from motor vehicles. These regulations are periodically updated to incorporate cleaner technologies and improve air quality in urban areas. In contrast, the GRIHA system is a dedicated framework for evaluating the environmental performance of buildings and infrastructure projects. While both initiatives aim for sustainability, they target entirely different sectors, with one focusing

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43. (C) Adjusting systems to moderate damages or cope with climate impacts.
The concept involves making necessary adjustments in human or natural systems to minimize the negative impacts of changing environmental conditions. It focuses on building resilience to cope with current and future shifts, such as rising sea levels or extreme weather events. While mitigation aims to reduce the causes of these changes, this approach ensures that society can still function effectively. Successful implementation requires integrated planning across various sectors like agriculture, infrastructure, and water management to ensure long-term stability.

44. (D) To promote hydro-power projects in the region.
The specialized mission focuses on assessing the ecological health of a sensitive mountain region and creating a database for better resource management. It supports states in implementing sustainable practices to protect the unique biodiversity and glacial systems found there. However, the initiative does not aim to promote large-scale power generation projects, which are often criticized for their potential environmental risks. Instead, it prioritizes scientific research and conservation to safeguard the critical services the ecosystem provides for millions of people.

45. (B) 1, 3, 4, and 5
Several specialized programs have been established to protect diverse species and their habitats. These initiatives cover iconic land mammals like tigers and elephants, as well as unique aquatic reptiles and the one-horned rhinoceros. While most of these projects are active and successful, the scope of national conservation efforts continues to evolve to address emerging threats. Each program employs specific strategies like habitat restoration and anti-poaching measures to ensure the long-term survival of the country's most vulnerable and significant wildlife.

46. (D) Methylmercury
A severe neurological disorder was caused by the discharge of a highly toxic organic compound into a bay. This substance accumulated in fish and shellfish, which were subsequently consumed by the local population. The disaster highlighted the dangers of industrial pollution and the process of biological magnification in food chains. It led to global awareness regarding the monitoring of heavy metal concentrations in the environment and the implementation of stricter wastewater treatment regulations to protect public health and safety.

47. (B) Conserving and judiciously using resources within a natural watershed.
The strategy focuses on the integrated management of land and water resources within a natural drainage area. It aims to conserve soil moisture, replenish groundwater, and improve agricultural productivity through techniques like building check dams and planting vegetation. By treating the entire basin as a single unit, the approach ensures sustainable resource use and reduces the risk of erosion and downstream flooding. This holistic method is essential for supporting rural livelihoods and ecological health in diverse landscapes across the country.

48. (C) Statement I is correct but Statement II is incorrect.
The national rating system provides a comprehensive method for assessing the environmental impact of buildings against established performance benchmarks. It evaluates various factors such as energy efficiency, water conservation, and the use of sustainable materials. Contrary to some misconceptions, a higher rating signifies better ecological performance and a lower environmental footprint. Following these standards helps developers create more sustainable urban spaces that align with national climate goals and reduce overall resource consumption in the built environment for sustainability.

49. (A) Greater One-horned Rhinoceros
The conservation initiative in Assam aims to increase the population of the greater one-horned rhinoceros through systematic relocation and habitat protection. By spreading the animals across multiple sanctuaries, the program reduces the risk of population loss due to disease or natural disasters. This strategic approach focuses on reaching specific population targets to ensure the species' long-term survival in the wild. It represents a successful collaboration between government agencies and international

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impacts of a warming planet and increasing demand.

36. (C) Iodine
The enlargement of the thyroid gland is a significant public health issue frequently linked to the lack of a specific essential mineral in the diet. This condition is most common in geographic regions where the soil and water naturally lack this element. Implementing salt fortification programs has been a highly effective strategy for reducing the prevalence of this disorder. Ensuring adequate intake of this nutrient is vital for healthy human growth and neurological development in vulnerable populations across regions.

37. (B) Olive Ridley Turtle
Conservation efforts on the eastern coast of India focus on protecting the mass nesting sites of a specific marine species. These turtles migrate long distances to reach specific beaches for their annual breeding cycles. The project involves community participation and modern technology to safeguard nesting grounds from predators and human interference. Protecting these fragile populations is essential for maintaining marine biodiversity and the overall health of the coastal ecosystem in the region for the benefit of biodiversity.

38. (D) Statement I is incorrect but Statement II is correct.
The process of capturing atmospheric carbon and storing it in natural or artificial sinks is vital for mitigating global warming. Conversely, releasing stored carbon would exacerbate the greenhouse effect. Financial instruments that represent the right to emit a specific quantity of pollutants provide a market-based incentive for companies to reduce their environmental impact. While one term describes a physical storage process, the other refers to a tradable permit used in international climate policy frameworks to achieve emission targets.

39. (D) Odisha
Local communities in the state of Odisha organized a powerful protest against a proposed large-scale mining project. The activists were concerned that extracting bauxite from the hills would destroy the unique biodiversity and the numerous medicinal plants found in the area. This movement emphasized the cultural and ecological significance of the landscape to the indigenous population. The success of the campaign demonstrated the importance of community voices in decisions regarding industrial and environmental development and ecological preservation.

40. (C) P-4, Q-1, R-3, S-2
The national climate strategy incorporates multiple specialized missions, each targeting a distinct environmental objective. Some focus on expanding renewable energy capacity like solar power, while others aim to improve urban planning through sustainable habitats. Significant efforts are also directed toward managing water resources efficiently and enhancing forest cover to act as carbon sinks. Together, these initiatives provide a comprehensive framework for addressing the diverse challenges posed by climate change while promoting long-term sustainable growth and national resilience.

41. (D) Abatement of pollution in rivers.
The government framework addresses the widespread pollution of major waterways by implementing abatement measures in various states. It focuses on treating domestic sewage and industrial effluents before they reach river systems to improve water quality. By coordinating efforts between central and state agencies, the plan aims to restore the ecological health of degraded rivers. This initiative is crucial for ensuring safe water for communities and maintaining the biological diversity of aquatic habitats in significant river basins across the country.

NODIA

42. (B) Aedes mosquito
The viral infection is transmitted to humans through the bite of infected mosquitoes, primarily those that breed in stagnant water near residential areas. These insects are known for their distinct markings and are most active during daylight hours. Managing the population of these vectors is a key strategy for controlling the spread of the disease. Public health measures often focus on removing potential breeding sites like discarded containers and improving urban drainage systems to protect public health and safety.

development planning and influenced future grassroots environmental movements.

15. (A) P-2, Q-4, R-1, S-3
Specific initiatives are designed to protect various endangered species and their environments. High-profile programs focus on increasing tiger numbers, while others address the migration paths of elephants and their corridors. Marine efforts often target the nesting sites of sea turtles on coastal beaches. Additionally, specialized missions work toward reviving populations of the one-horned rhinoceros in their native habitats. Together, these projects form a comprehensive framework for safeguarding the country's diverse wildlife and natural heritage.

16. (B) National Mission on Strategic Knowledge for Climate Change
A dedicated mission under the national climate framework focuses on building a robust scientific understanding of climate change. It aims to strengthen research infrastructure and foster collaboration between academic and scientific institutions. By generating reliable data and predictive models, the initiative helps policymakers develop informed strategies for adaptation and mitigation. Strengthening national expertise in climate science is essential for addressing future environmental challenges and ensuring sustainable development across all sectors of the economy for the future.

17. (B) Thermal expansion of seawater and melting of land-based ice.
Rising global temperatures lead to higher ocean levels primarily through two mechanisms. First, as seawater warms, it increases in volume through a physical process known as expansion. Second, the melting of glaciers and polar ice sheets adds significant quantities of liquid water to the basins. Together, these factors threaten coastal communities with flooding and erosion. Understanding these dynamics is critical for planning future adaptation strategies in vulnerable low-lying regions to protect human populations and ecosystems.

18. (B) Both Statement I and Statement II are incorrect.
Large-scale dam projects often face geographical and jurisdictional disputes. One major structure is located in the Himalayan state of Uttarakhand rather than Himachal Pradesh. Another significant dam on the Krishna River has been at the center of water-sharing disagreements among several neighboring states. These examples illustrate the complexities of managing shared water resources, where regional needs must be balanced with ecological sensitivity and legal agreements across different state boundaries for sustainable resource management.

19. (C) Generation of solar power in rural areas.
The national cleanliness campaign targets several key pillars of public health and sanitation. It focuses on ending open defecation, managing municipal solid waste, and eradicating the practice of manual scavenging. While the initiative covers broad environmental health goals, it does not specifically include rural renewable energy generation. Its primary success lies in behavioral change and the large-scale construction of sanitation facilities to improve the overall living standards of citizens and achieve a cleaner environment.

20. (A) 1, 2, 3 and 4
Major environmental catastrophes have varied origins, ranging from industrial chemical leaks to nuclear accidents. Historical incidents include severe neurological poisoning from heavy metals and toxic gas releases from pesticide plants. Other crises resulted from failures at power facilities, sometimes triggered by natural events like earthquakes and tsunamis. However, events involving buried chemical waste are distinct from volcanic activity. Identifying these specific causes is essential for developing safety regulations and disaster response protocols to prevent future ecological tragedies.

21. (C) Storing rainwater for future use and recharging local groundwater.
The technique involves collecting and storing precipitation directly from roofs or ground surfaces for later use. It serves as an effective way to manage local water supplies, especially in areas facing seasonal scarcity. By directing excess water into the ground, it also helps replenish depleted aquifers and raises the local water table. This sustainable practice reduces reliance on external water sources and minimizes the impacts of

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conservation organizations to safeguard unique wildlife and their natural habitats.

50. (B) A growing forest absorbing CO2 from the atmosphere.
The process of removing carbon dioxide from the atmosphere and storing it in biomass is a key natural mechanism. Growing forests act as significant sinks by absorbing the gas during photosynthesis and incorporating it into trees and soil. This biological storage helps mitigate the greenhouse effect and stabilize global temperatures. Protecting existing woodlands and undertaking large-scale afforestation are critical strategies for enhancing this natural capacity and achieving climate goals through nature-based solutions and integrated environmental planning across the country.

51. (C) Methyl isocyanate (MIC)
A catastrophic industrial accident occurred when a highly toxic gas leaked from a chemical facility in a densely populated city. The incident caused immediate fatalities and long-term health complications for thousands of residents. The specific compound involved is an intermediate chemical used in the production of pesticides. This tragedy emphasized the urgent need for stringent safety regulations and disaster management protocols in industrial zones. It remains one of the world's most severe environmental and industrial disasters, impacting thousands of lives over decades.

52. (D) Eight
The national framework for addressing climate change consists of a specific set of eight specialized missions. Each initiative targets a different sector, such as solar energy, water management, sustainable habitats, and forest conservation. By coordinating these diverse efforts under one plan, the country aims to achieve balanced growth while mitigating environmental impacts. This multi-faceted approach is essential for integrating climate resilience into national development and meeting international commitments for greenhouse gas reduction and sustainable resource use for the future.

53. (C) Ecological fragility, seismic risks, and displacement.
Large-scale power projects in mountainous regions often face significant opposition due to the inherent geological instability of the landscape. High seismic risks and the potential for landslides make such constructions hazardous for both the environment and local communities. Additionally, the submergence of land leads to the displacement of indigenous populations and the loss of fragile ecosystems. These concerns highlight the difficult balance between pursuing renewable energy goals and protecting the ecological integrity of sensitive high-altitude areas in mountain states.

54. (B) Ozone layer depletion is primarily caused by greenhouse gases like carbon dioxide and methane.
The thinning of the protective atmospheric layer is primarily caused by specific man-made chemicals used in refrigeration and aerosols rather than common greenhouse gases. While carbon dioxide and methane contribute significantly to global warming, they do not directly destroy ozone molecules. International agreements have successfully targeted the phase-out of these harmful substances to allow the layer to recover. Understanding the distinct causes of different environmental issues is vital for developing effective policies and targeted scientific responses to protect the biosphere.

55. (B) 1, 2, 3 and 4
Several significant grassroots initiatives in India have focused specifically on protecting trees and forest ecosystems from commercial exploitation. These movements often involved local communities and indigenous people who used non-violent methods to prevent large-scale felling. While they occurred in different regions and at different times, they shared a common goal of preserving biodiversity and sustainable livelihoods. These actions have been instrumental in shaping national forest policies and increasing public awareness about the vital importance of ecological conservation for sustainability.

56. (D) Promoting energy efficiency as a core component of urban planning.
The mission focuses on making urban areas more resilient and environmentally friendly by integrating energy efficiency into building codes and city planning. It also addresses critical issues

NODIA

97. (B) Bauxite mining that threatened local ecology and livelihoods.
Local communities in Odisha organized a significant movement to protest against a large-scale bauxite mining project that threatened their traditional lands. The hills are known for their exceptional biodiversity and serve as a vital source of medicinal plants and fresh water for the region. Activists successfully highlighted how industrial activities would destroy the delicate ecological balance and undermine the livelihoods of the indigenous people. This victory demonstrated the power of collective action in protecting natural heritage from unsustainable industrial expansion and degradation.

98. (A) Both Statement I and Statement II are correct.
The national conservation initiative focuses on the long-term survival of wild elephants by protecting their natural habitats and critical migration paths. A major part of this effort involves the identification and management of corridors that allow these large mammals to move safely between different forested areas. By reducing fragmentation and managing human-wildlife conflict, the program helps maintain healthy populations and the ecological integrity of their environment. This comprehensive approach is essential for safeguarding one of the country's most ecologically significant and iconic wildlife species for the future.

99. (D) Risks in a geologically sensitive and seismic Himalayan zone.
Large-scale power projects in the high mountain regions are often controversial because of the inherent geological sensitivity and high seismic risk of the landscape. Constructing massive infrastructure in these areas can increase the likelihood of landslides and other natural disasters, threatening both the environment and local populations. Additionally, the diversion of river water can disrupt fragile aquatic ecosystems and affect the traditional livelihoods of mountain communities. These concerns emphasize the need for rigorous environmental impact assessments and the consideration of safer and more sustainable energy alternatives for biodiversity.

100. (D) Set permissible limits for air pollutants from vehicle exhaust.
The primary objective of implementing stringent standards for motor vehicle exhaust is to set permissible limits for various air pollutants. These regulations target substances like carbon monoxide and particulate matter to improve overall air quality, particularly in densely populated urban centers. By mandating the use of advanced engine technologies and cleaner fuels, the government aims to reduce the environmental and health impacts of the growing transport sector. These norms are periodically updated to align with global standards and ensure continuous progress toward cleaner atmospheres.

101. (B) Creating sewerage treatment infrastructure.
A key component of the comprehensive river rejuvenation mission is the establishment of robust infrastructure for wastewater management. This involves building and modernizing sewage treatment plants to prevent untreated domestic and industrial waste from entering the river system. By focusing on pollution abatement at the source, the program aims to restore the water quality and ecological health of this significant waterway. This effort is vital for protecting public health and safeguarding the diverse biodiversity that depends on the river's resources for survival.

102. (D) Appiko movement
A grassroots movement in the southern state of Karnataka emerged as a direct parallel to the Himalayan tree-hugging protests. Local communities used non-violent resistance to stop the commercial felling of trees in the Western Ghats, emphasizing the need to protect the region's unique biodiversity. The movement also focused on promoting sustainable forest management and the planting of new saplings to restore degraded areas. This campaign was a significant milestone in the history of Indian environmentalism, highlighting the vital role of local action in conservation.

103. (A) Ensuring a reliable, affordable supply of energy, with an increasing focus on sustainable and low-carbon sources.
The concept involves ensuring that a nation has a reliable and affordable supply of energy to meet its developmental needs. In the context of a changing climate, this goal increasingly emphasizes a transition toward sustainable and

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These disputes typically center on the allocation of river flow for irrigation, industry, and domestic use across state boundaries. Examples include long-standing conflicts over major southern and eastern river systems. Resolving these tensions requires legal frameworks and cooperative management to ensure equitable access to water while protecting the ecological health of the entire basin for future generations and sustainable growth.

64. (D) Sustainable Habitat
The concept of environmentally responsible construction is most closely linked to the goal of creating sustainable living environments. This approach emphasizes reducing the overall footprint of buildings through efficient resource management and the use of eco-friendly materials. It is a key component of national missions that target urban development and climate resilience. By following these principles, planners can create habitats that are healthier for residents and less damaging to the natural world, aligning with broader national sustainability goals.

65. (B) P-2, Q-1, R-4, S-3
Significant environmental campaigns have occurred across various states, each addressing specific local ecological threats. Some initiatives began in the Himalayan region to protect forests, while others emerged in the southern Western Ghats or the eastern hills. These movements were often driven by grassroots activism against dams, mining, or commercial felling. By mapping these efforts to their respective regions, researchers can better understand the diverse socio-ecological history of the country and the persistent role of community-led conservation actions.

66. (B) A major earthquake and subsequent tsunami.
The massive release of radioactive material from a nuclear facility followed a catastrophic natural event. A powerful offshore earthquake generated a massive wave that overwhelmed the plant's safety systems and led to multiple reactor failures. This crisis highlighted the vulnerability of coastal infrastructure to extreme geohazards and prompted a global review of nuclear energy safety. It emphasized the need for more robust emergency protocols and the careful selection of sites for sensitive industrial and power-generating facilities globally.

67. (B) The Ramsar Convention on Wetlands.
While many environmental programs are managed at the national level, some are based on global treaties designed to protect specific types of ecosystems. An international agreement focused on the conservation and wise use of wetlands is a prime example of such cooperation. It encourages member nations to protect habitats that are of global significance for biodiversity and water security. Participating in these treaties allows countries to align their local conservation strategies with international standards and receive global recognition for their efforts.

NODIA

68. (A) Manage water resources for conservation and equitable distribution.
The initiative seeks to ensure the sustainable management of water resources through conservation, waste reduction, and equitable distribution across different regions. It focuses on improving water use efficiency and developing comprehensive databases to monitor availability and quality. By promoting integrated water resources management, the mission helps the country adapt to the challenges posed by climate change and growing demand. This strategic framework is essential for securing a reliable water supply for agriculture, industry, and domestic needs in the future years.

69. (C) Climate change causes unpredictable farming and reduced crop yields.
Global changes in temperature and rainfall patterns directly threaten the stability of food systems. These shifts can lead to more frequent droughts, floods, and changes in the growing seasons, making traditional farming less predictable and reducing overall crop yields. Such disruptions can cause food shortages and significant price volatility, particularly affecting vulnerable populations. Adapting agricultural practices and developing climate-resilient crop varieties are essential steps to ensure that global populations have consistent access to sufficient and nutritious food in the future.

70. (B) 1, 2 and 4
The national framework was established to guide a multi-sectoral response to the challenges

like solid waste management and the promotion of public transportation to reduce the urban carbon footprint. By encouraging the adoption of green building standards, the initiative aims to minimize resource consumption in growing cities. This holistic approach is essential for creating liveable and sustainable environments in an increasingly urbanized world and reducing the environmental impact.

57. (A) Reducing the inflow of nutrients and removing excess algal bloom.
Reversing the degradation of lakes involves strategies to decrease the excessive input of nitrates and phosphates from agricultural and industrial sources. Physical removal of accumulated algal biomass is often necessary to restore water clarity and dissolved oxygen levels. These actions help prevent fish kills and restore the natural biological balance of the aquatic ecosystem. Long-term success requires managing land use in the surrounding area to ensure that nutrient runoff remains within sustainable levels for the health of the environment.

58. (C) To regulate and reduce the amount of pollutants emitted by vehicles.
The primary objective of implementing standardized norms for vehicles is to control and minimize the release of harmful pollutants into the atmosphere. These regulations target substances like nitrogen oxides and particulate matter, which contribute significantly to urban air pollution and respiratory health problems. By mandating the use of cleaner technologies, the government aims to improve overall air quality. These standards are periodically updated to reflect advancements in engineering and more stringent environmental protection goals for the growing national transport sector.

59. (A) Ukraine
The catastrophic nuclear accident that occurred in the mid-1980s took place at a power facility located in present-day Ukraine. The event released massive quantities of radioactive material into the atmosphere, affecting large parts of Europe. This disaster led to a global reassessment of nuclear safety standards and the long-term health impacts of radiation exposure. The site remains a significant focus for environmental research and serves as a reminder of the potential risks associated with nuclear power generation for global safety.

60. (A) Both A and R are true and R is the correct explanation of A.
Contamination of groundwater with toxic levels of a naturally occurring element is a major health threat in several river basins. Prolonged consumption of this water leads to severe skin lesions and internal ailments. This issue is particularly acute in areas where deep wells tap into contaminated aquifers. Addressing this crisis requires providing filtered water and raising awareness about the dangers of long-term exposure. Scientific research continues to map the extent of this problem to protect vulnerable populations in affected geological regions.

61. (D) The displacement of the upper layer of soil; a form of soil degradation.
The removal of the top layer of earth by physical forces like water and wind is a major form of land degradation. This process strips the land of its most fertile components, reducing its ability to support agriculture and natural vegetation. Factors like deforestation and unsustainable farming practices often accelerate this displacement. Implementing conservation techniques such as planting cover crops and building barriers is essential for protecting soil health and ensuring long-term food security and the health of the environment.

62. (B) Supporting states in protecting elephants, habitats, and corridors.
The centrally sponsored initiative focuses on the long-term survival of wild elephants by protecting their natural habitats and critical migration corridors. It provides technical and financial support to states to manage human-elephant conflicts and prevent poaching. By ensuring that these large mammals have sufficient space and resources, the program helps maintain the ecological balance of the forests they inhabit. This comprehensive approach is vital for the conservation of one of the country's most iconic and ecologically significant wildlife species.

63. (A) Both Statement I and Statement II are correct.
Disagreements over the sharing of water resources between different regional governments are common environmental and political issues.

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77. (B) Assessing the environmental performance of buildings.
The dedicated rating framework is designed to evaluate the environmental performance of buildings and infrastructure projects throughout their entire life cycle. It assesses factors such as energy efficiency, water management, and the use of sustainable building materials. By providing a standardized set of benchmarks, the system helps developers and architects create structures that are more resource-efficient and have a lower ecological impact. This tool is essential for promoting sustainable urban development and meeting national targets for a greener and sustainable habitat.

78. (A) Both Statement I and Statement II are correct.
Documenting local biological resources and the traditional knowledge associated with them is a vital conservation practice. This record helps communities track their natural heritage and protect it from unauthorized exploitation. Furthermore, such documentation provides a legal basis for ensuring that benefits derived from these resources are shared equitably with the local people. This decentralized approach strengthens community participation in environmental management and helps preserve indigenous wisdom for future generations, while also supporting national biodiversity goals and international legal environmental obligations.

79. (C) National River Conservation Plan.
Various river cleaning initiatives are part of a broader national framework designed to improve the health of the country's major waterways. This umbrella program coordinates efforts to intercept and treat domestic sewage and industrial wastewater before they enter river systems. By focusing on pollution abatement and habitat restoration, these plans aim to bring river water quality back to acceptable standards. This integrated approach is essential for ensuring the sustainability of water resources and protecting the diverse ecosystems that depend on them.

80. (A) 1, 2 and 3
The concept of creating environmentally friendly living spaces involves a multi-faceted approach that includes green building standards and efficient resource management. It is a key component of national climate strategies and utilizes specialized rating systems to assess the performance of urban infrastructure. While these efforts are particularly important in rapidly growing cities, they aim to create sustainable environments for all residents. By integrating energy efficiency and waste management into urban planning, the country can build resilience and reduce its overall environmental impact.

NODIA

81. (A) The region's rich biodiversity and indigenous communities.
The construction of large power generation facilities in the northeastern region faces significant scrutiny due to its potential impact on the area's exceptional biodiversity. The region is home to many endemic species and unique forest ecosystems that could be disrupted by large-scale flooding. Additionally, these projects often affect the traditional lands and livelihoods of indigenous communities. These concerns highlight the complexities of pursuing renewable energy targets while trying to preserve the delicate ecological and social balance of a highly sensitive mountain environment.

82. (B) Increase forest cover and protect/restore forest ecosystems.
The specialized mission focuses on expanding national forest and tree cover to enhance biodiversity and increase atmospheric carbon capture. It aims to restore degraded ecosystems and improve the quality of existing woodlands, which also supports the livelihoods of communities that depend on forest resources. By strengthening ecological infrastructure, the initiative plays a critical role in the country's overall strategy for climate change mitigation and adaptation. This long-term effort is essential for maintaining healthy ecosystems and achieving national environmental sustainability goals for biodiversity.

83. (C) Arsenocosis
Regular consumption of water containing high levels of a specific toxic element leads to a chronic medical condition characterized by skin lesions and potential internal damage. This environmental health issue is prevalent in river basins where the groundwater is naturally contaminated. Managing this problem requires a combination of providing alternative safe water sources and implementing effective filtration

The integrated management of land and water within a natural drainage area is a cornerstone of national conservation strategy. By implementing measures like check dams and soil stabilization, these projects help capture rainfall, reduce erosion, and replenish groundwater supplies. This holistic approach not only protects the environment but also enhances agricultural productivity and the long-term sustainability of rural communities. The success of these programs illustrates the vital role of decentralized, ecological planning in managing the country's precious natural resources for future generations.

111. (B) To capture and store rainwater where it falls for future use or groundwater recharge.
The fundamental idea behind this technique is to capture and store precipitation exactly where it falls rather than allowing it to run off and be lost. This water can then be used for domestic purposes, irrigation, or directed into the ground to recharge depleted aquifers. By effectively managing local rainfall, communities can reduce their reliance on distant or over-exploited water sources and build resilience against seasonal scarcity. This sustainable practice is a vital component of integrated water resource management.

112. (B) Namami Gange and Yamuna Action Plan
The national framework for protecting and restoring major waterways serves as the overarching program for several significant river cleaning initiatives. It provides a coordinated approach to address widespread pollution by implementing abatement measures in various states. By focusing on the interception and treatment of sewage, the plan aims to improve the overall water quality and ecological health of important rivers like the Ganga and Yamuna. This integrated strategy is essential for ensuring sustainable water resources and protecting diverse biological communities.

113. (C) Depletion of dissolved oxygen, leading to fish kills.
The excessive enrichment of water bodies with nutrients leads to the rapid growth of algae, which eventually results in a severe depletion of dissolved oxygen when the biomass decomposes. This hypoxic condition is a direct cause of mass mortality among fish and other aquatic organisms, disrupting the entire food web. Additionally, the process can lead to a significant decline in water clarity and the emergence of toxic algal blooms. These changes severely degrade ecological health and reduce suitability for human and wildlife use.

114. (D) The Biological Diversity Act, 2002
A significant piece of national legislation mandates the formal documentation of local biological resources and the traditional knowledge associated with them through a decentralized register. This legal framework ensures that communities have a say in the management of their natural heritage and are protected from the unauthorized commercialization of their resources. By establishing these records at the local level, the law promotes the conservation of biodiversity and ensures that benefits from its use are shared fairly with the local community.

115. (B) P-4, Q-1, R-3, S-2
Various environmental concepts play distinct roles in global sustainability efforts. Some involve capturing and storing atmospheric gases to mitigate warming, while others represent market-based permits for emissions. Additionally, there are frameworks for evaluating the performance of buildings and descriptions for the nutrient enrichment of water bodies. Understanding these terms is essential for following international climate policies and implementing effective national conservation strategies. Together, they form a comprehensive vocabulary for addressing the diverse challenges of ecological protection in the modern world.

116. (D) The Gharial, Saltwater Crocodile, and Mugger.
The national conservation effort focuses on the breeding and management of three distinct species of large reptiles native to the region's diverse habitats. These include the long-snouted, fish-eating Gharial, the widespread freshwater Mugger, and the large Saltwater Crocodile found in coastal environments. By establishing protected areas and conducting research, the program aims to revive these populations and prevent their extinction. This specialized initiative addresses the specific ecological needs of each species while managing the potential for human-wildlife conflict.

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More recent events were triggered by natural disasters in the twenty-first century. Additionally, earlier incidents involving buried chemical waste highlighted the long-term dangers of industrial pollution. Mapping these events helps researchers track the evolution of global environmental and industrial risks.

91. (D) National Mission for Clean Ganga.
The national climate strategy is structured around eight specialized missions that target different aspects of environmental sustainability and resilience. These initiatives cover areas like renewable energy, water conservation, and forest protection. While cleaning major river systems is a top government priority and is managed through significant national programs, it is not listed as one of the specific missions under the climate action plan. This distinction helps in understanding how various environmental and developmental goals are organized and implemented through different ministerial frameworks and policy structures.

92. (B) High seismic activity.
The construction of a massive dam in a sensitive Himalayan region faced intense opposition due to its location in an area prone to significant earthquakes. Critics argued that the structural integrity of the project could be compromised, posing a major threat to downstream populations. Additionally, the project necessitated the submergence of an old town and the displacement of many local residents. These issues underscore the complex trade-offs between pursuing large-scale hydroelectric development and managing the risks associated with building in geologically unstable environments.

93. (C) Wetlands of international importance.
Specific areas identified under an international treaty as wetlands of global significance are given a special designation to ensure their protection and sustainable use. These sites can include various ecosystems like marshes, peatlands, and coastal waters that provide essential services and support diverse wildlife. By participating in this convention, countries commit to maintaining the ecological character of these habitats. This global network of protected areas is crucial for conserving biodiversity, managing water resources, and helping human communities adapt to the climate impacts.

94. (D) Adjusting to the current and future effects of climate change.
The concept focuses on the ability of human and natural systems to adjust to current or anticipated changes in the environment to minimize potential damage. It involves implementing strategies like building resilient infrastructure, developing drought-resistant crops, and improving disaster management protocols. While mitigation seeks to reduce the causes of these changes, this approach ensures that society can effectively cope with the impacts that are already occurring or expected. Successful adaptation is essential for maintaining social stability and economic growth in a changing global climate.

95. (A) 1, 2, and 4
Rising global temperatures lead to several major environmental shifts that impact the entire planet. These include higher sea levels due to melting ice and the expansion of seawater, as well as a significant increase in the frequency and intensity of extreme weather events. Such changes also disrupt habitats and contribute to a decline in biological diversity. While other environmental issues exist, they are often caused by different chemical processes. Understanding these specific outcomes is vital for developing effective international policies and national resilience.

96. (B) To build a vibrant and dynamic knowledge system for the country.
The mission seeks to build a vibrant and dynamic knowledge system to support national action on climate change. It focuses on strengthening the research infrastructure and fostering collaboration among scientific institutions to generate reliable data and predictive models. By improving the accessibility of information, the initiative helps policymakers develop informed strategies for both adaptation and mitigation. This specialized mission is essential for ensuring that the country's response to environmental challenges is grounded in the best available science and a robust understanding of future risks.

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technologies at the community level. Public health interventions focus on early detection and reducing exposure to prevent the long-term debilitating effects of this mineral poisoning.

84. (D) Implementing sustainable land and water management practices.
Addressing the spread of arid conditions requires the implementation of integrated land and water management practices. Effective strategies include large-scale afforestation to stabilize soil and the adoption of sustainable farming techniques to prevent over-cultivation. Managing livestock grazing is also crucial to protect fragile vegetation cover in semi-arid regions. By restoring the natural productivity of the land, these measures help communities become more resilient to climatic variations and prevent the further degradation of fertile areas into barren and unproductive landscapes.

85. (C) A is true but R is false.
The historic environmental movement in the Himalayan region was a landmark campaign for forest protection. It was driven by local communities who used non-violent resistance to stop commercial logging and prevent the destruction of their natural resources. While it significantly impacted national ecological policies, the movement was primarily focused on tree conservation rather than protesting against large-scale dam projects. This distinction is important for understanding the specific goals of different grass roots actions and their unique contributions to the broader movement in India.

86. (B) Establishment of a tiger reserve under 'Project Tiger'.
Protecting endangered species within their natural environment is a key strategy for maintaining biological diversity. Establishing large reserves where wildlife can live and breed without human interference is a prime example of this approach. These protected areas also preserve the entire ecosystem, including the various plants and smaller animals that share the habitat. By focusing on the natural setting, conservationists can ensure that species retain their natural behaviors and ecological roles, which is essential for the long-term stability of the overall environment.

87. (D) Ozone layer depletion
The release of specific man-made chemicals into the atmosphere is the primary cause of the thinning of the protective stratospheric shield. These substances break down ozone molecules, allowing more harmful ultraviolet radiation to reach the Earth's surface. This phenomenon poses significant risks to human health and the environment, leading to a global effort to phase out their use. Unlike other environmental challenges caused by common greenhouse gases, this issue is directly linked to the use of compounds once common in refrigeration and aerosols.

88. (C) Statement I is correct but Statement II is incorrect.
The national mission aims to transform the agricultural sector by making it more resilient to the impacts of changing climatic conditions. It focuses on promoting sustainable farming practices, improving soil health, and enhancing water use efficiency. While the initiative encourages the development of climate-resilient crop varieties, it does not exclusively rely on genetic modification. Instead, it employs a broad range of traditional and modern strategies to ensure food security and maintain rural livelihoods despite the challenges posed by a warming environment.

89. (A) Sanitation and public health.
A central pillar of the national cleanliness campaign is the elimination of open defecation to improve public health and hygiene. By ensuring that every household and community has access to proper sanitation facilities, the program significantly reduces the transmission of waterborne and fecal-oral diseases. This effort also enhances the dignity and safety of citizens, particularly women and children. Achieving this status is a vital step toward creating a cleaner environment and improving the overall health outcomes for millions of people.

90. (C) P-4, Q-1, R-2, S-3
Major environmental and industrial catastrophes have occurred at various points over the last several decades, each leaving a lasting impact on safety regulations. This timeline includes significant gas leaks in the early 1980s and major failures at nuclear facilities shortly thereafter.

NODIA

low-carbon sources like wind and solar power. By diversifying the energy mix and reducing dependence on imported fossil fuels, a country can enhance its economic stability while also mitigating its environmental impact. This strategic shift is essential for achieving long-term sustainability and meeting international commitments.

104. (C) Afforestation and soil conservation measures.
Restoring the quality and productivity of degraded land requires the implementation of integrated conservation measures. Effective strategies include large-scale afforestation to stabilize the soil and prevent erosion, along with the adoption of sustainable agricultural practices to rebuild soil health. These efforts help transform barren or unproductive areas back into functional ecosystems that can support biodiversity and provide essential resources. Successful reclamation is vital for food security and environmental resilience, as it reduces the loss of arable land and enhances overall landscape health.

105. (C) 1, 3 and 4
The specialized initiative focuses on several key areas to protect a sensitive mountain region, including the continuous assessment of its ecological health. It aims to develop a comprehensive database of natural resources to inform better management and policy decisions. Furthermore, the mission supports states in implementing sustainable development actions that are tailored to the unique challenges of the high-altitude environment. By prioritizing scientific research and conservation, the program seeks to safeguard the critical ecosystem services and biodiversity that millions of people depend on annually.

106. (D) Arribadas
A remarkable natural phenomenon occurs when thousands of female sea turtles arrive simultaneously on specific beaches to lay their eggs. These mass nesting events, often occurring in coastal regions like Odisha, are a critical stage in the life cycle of the species. Conservation projects focus on protecting these sites from predators and human interference to ensure high hatching success. Safeguarding these unique events is essential for the long-term survival of the turtle populations and for maintaining the ecological health of marine environments.

107. (B) Only rivers can be designated as Ramsar sites.
The international treaty for the protection of wetlands covers a diverse range of ecosystems, not just rivers. These can include marshes, peatlands, lakes, and even coastal marine areas that are of international importance for biodiversity. Many such sites have been designated in India to ensure their sustainable management and conservation. While rivers are vital components of many wetland systems, the convention's scope is much broader, aiming to safeguard all types of fragile environments that provide essential water services and critical habitats.

108. (C) Assam
The ambitious conservation program focused on achieving a specific population target for the greater one-horned rhinoceros in its native state of Assam. By relocating animals to several protected areas, the initiative aimed to reduce the risk of localized extinction and promote the growth of wild populations. This strategic approach involved improving habitat management and strengthening anti-poaching measures across different sanctuaries. The success of this vision is a significant achievement in wildlife conservation, demonstrating how coordinated efforts can effectively protect and revive endangered species.

109. (D) Submergence of large areas of forests and agricultural land, and displacement of communities.
Large-scale river projects often face significant socio-environmental criticism due to the massive changes they cause in the landscape. The construction of massive dams leads to the submergence of vast areas of natural forest and productive agricultural land, resulting in a loss of biodiversity and livelihoods. Furthermore, such projects frequently necessitate the large-scale displacement of local communities, many of whom have lived on the land for generations. These impacts highlight the deep conflicts between pursuing industrial development and protecting ecological and social integrity.

110. (A) Both A and R are true and R is the correct explanation of A.

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of climate change. It comprises eight distinct missions that target areas such as renewable energy, water security, and sustainable urban habitats. While the plan addresses emission reductions, its broader focus includes adaptation and building national resilience. Contrary to some beliefs, river cleaning programs like Namami Gange are separate initiatives managed under different government bodies. This strategic plan remains the cornerstone of the country's national climate action.

71. (D) Afforestation and preventing soil erosion.
Restoring the productivity of degraded landscapes involves a combination of biological and physical interventions. Planting trees and establishing vegetation cover are highly effective for stabilizing soil and preventing further loss of topsoil. These efforts also help rebuild organic matter and improve the land's ability to retain moisture. By implementing such conservation measures, it is possible to transform unproductive areas into healthy ecosystems or fertile agricultural ground, thereby supporting biodiversity and enhancing the local community's sustainable resources for the long term.

72. (B) Goitre
Various health conditions are directly linked to environmental contamination or the presence of specific disease-carrying organisms. Issues like dental and skeletal deformities or chronic skin lesions often result from minerals in groundwater. Similarly, certain viral infections are spread by insects that thrive in stagnant water. However, some conditions arise from nutritional deficiencies in the local diet, such as a lack of iodine, and are not primarily caused by water pollution or disease vectors. Distinguishing these causes is vital for public health.

73. (D) Waste management and sanitation.
The national campaign is a comprehensive effort to improve the quality of life through enhanced sanitation and hygiene practices. It places a significant emphasis on managing solid waste and ending the practice of open defecation across both rural and urban areas. By building millions of toilets and promoting behavioral change, the initiative aims to reduce the spread of diseases and improve public health. This massive program is a key part of the country's commitment to achieving universal sanitation and environmental cleanliness.

74. (A) Protect the Bengal tiger and its habitat from extinction.
The high-profile conservation venture was launched to prevent the extinction of a major apex predator by protecting its natural habitats. It focuses on maintaining viable populations of tigers within designated reserves, which also helps preserve the entire ecosystem and its biodiversity. By implementing strict anti-poaching measures and scientific monitoring, the program has become a global model for wildlife conservation. Its success demonstrates that focused government action can effectively safeguard endangered species and their environments from human-induced threats across the country.

75. (B) 2, 1, 3, 4
Grassroots environmental actions in India have emerged over several decades in response to different ecological threats. The sequence began with Himalayan protests against commercial logging, followed by campaigns in the southern evergreen forests. Shortly thereafter, similar initiatives spread to the Western Ghats of Karnataka and the bauxite-rich hills of the eastern region. These movements represent a significant historical trend of community-led resistance to unsustainable development, highlighting the growing national consciousness regarding the importance of protecting forests and natural resources.

76. (D) Capturing and storing atmospheric carbon dioxide long-term.
The process involves the long-term capture and storage of atmospheric carbon dioxide to help mitigate the effects of global warming. This can occur naturally through biological systems like forests and oceans, or through engineered technologies that inject the gas into underground geological formations. By reducing the concentration of greenhouse gases in the atmosphere, these methods play a vital role in international climate strategies. Enhancing these natural and artificial sinks is essential for achieving long-term sustainability and balancing global carbon cycles effectively.

NODIA

117. (B) National Mission for Sustainable Habitat
The mission specifically targets the urban environment by promoting energy efficiency in building designs and improving municipal systems for waste management. It also encourages a transition toward more sustainable public transportation to reduce the overall carbon footprint of growing cities. By integrating these sustainability goals into city planning and building codes, the initiative aims to create liveable and resource-efficient habitats. This multi-faceted approach is essential for building national resilience against climate change and ensuring long-term sustainable growth in increasingly urbanized environments.

118. (D) Statement I is incorrect but Statement II is correct.
Rising ocean levels are not a uniform global phenomenon; the rate can vary significantly between different coastal regions due to local geological and climatic factors. A major driver of this change is the thermal expansion of seawater as it absorbs heat from the warming atmosphere. Additionally, the influx of water from melting land-based ice contributes significantly to the overall volume. Understanding these dynamics is critical for developing effective adaptation strategies for vulnerable low-lying areas and protecting coastal infrastructure from inundation.

119. (B) A proposed hydroelectric dam.
A successful environmental campaign in the southern state of Kerala was organized to protect a unique tropical evergreen forest from being submerged by a proposed power facility. The area is renowned for its exceptional biodiversity and served as a critical habitat for many rare and endangered species. Activists argued that the ecological value of the pristine environment far outweighed the benefits of the project. This landmark victory demonstrated the importance of prioritizing ecological conservation over industrial development in fragile regions.

120. (A) 1, 2, 4, and 5
Various specialized initiatives have been established to protect diverse animal populations and their environments. High-profile programs focus on apex predators like tigers and large land mammals like elephants and rhinoceroses. Additionally, efforts are directed toward conserving unique aquatic reptiles like the Gharial and marine species like sea turtles. Each project employs tailored strategies such as habitat restoration, anti-poaching measures, and community involvement to ensure long-term survival. These coordinated efforts are vital for maintaining the country's rich biodiversity.

121. (A) Climate change.
A major objective of the national mission is to help the farming sector adapt to the challenges posed by an unpredictable and changing climate. It focuses on developing and promoting sustainable techniques that improve soil health and enhance water use efficiency. By encouraging the adoption of climate-resilient crop varieties and integrated farming systems, the initiative seeks to ensure long-term food security and maintain rural livelihoods. This proactive approach is essential for building national resilience and protecting the agricultural economy.

122. (C) Acid rain
Several environmental challenges are considered global because they cross national borders and require international cooperation to solve. These include climate change, the loss of biological diversity, and the thinning of the atmospheric protective layer. While certain types of air pollution can fall across borders, they are often addressed through regional agreements rather than being viewed as primary global issues in the same category as those mentioned above. Understanding the scale of these problems is vital for developing effective policies.

123. (A) Swachh Bharat Mission (Gramin/Rural) and Swachh Bharat Mission (Urban)
The massive national cleanliness campaign is organized into two primary pillars to address the specific needs of different areas. One component focuses on improving sanitation and waste management in rural villages, while the other targets the challenges found in rapidly growing urban centers. By coordinating efforts across both these sectors, the initiative aims to achieve universal sanitation coverage and create a cleaner environment for all citizens. This comprehensive approach is essential for reducing the spread of diseases and improving health.

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minerals in groundwater, leading to dental and skeletal deformities, while others are caused by nutritional deficiencies. Additionally, chronic exposure to toxic elements can lead to severe skin lesions. However, certain mosquito-borne illnesses are viral infections rather than bacterial diseases. Understanding these specific causes is vital for public health interventions, which include providing safe water and ensuring nutrition.

181. (A) Greater One-horned Rhino
A dedicated conservation program in the northeastern state of Assam focuses on increasing the wild population of the greater one-horned rhinoceros. By relocating individuals to multiple protected sanctuaries, the initiative aims to expand the species' range and reduce risks associated with habitat loss or disease. This strategic effort includes strengthening anti-poaching measures and improving habitat management to ensure survival. The program is a successful model of how scientific planning and coordinated action can effectively protect iconic and endangered wildlife.

182. (B) Form a data bank and knowledge-sharing platform on climate change.
A major objective of the specialized initiative is to build a vibrant knowledge system and information-sharing platform to support national policy-making on climate change. It focuses on strengthening research infrastructure and fostering collaboration between scientific institutions to generate reliable data and sophisticated climate models. By making this scientific information more accessible, the mission helps the country develop informed strategies for both adaptation and mitigation. This effort is essential for ensuring that the response to environmental challenges is grounded.

183. (C) Uttarakhand (then part of Uttar Pradesh)
The historic environmental campaign that involved local communities embracing trees to prevent commercial logging originated in the Himalayan region of a northern state. This landmark movement highlighted the deep connection between rural livelihoods and the protection of natural forest resources. By using non-violent resistance, activists successfully challenged unsustainable development practices and significantly influenced future national ecological policies. The movement's success became a global symbol of the power of grassroots action and the importance of community involvement in conservation.

184. (D) 20%
A major objective of the national mission is to significantly enhance the efficiency of water usage across all sectors by a specific target of twenty percent. This goal is critical for managing the country's limited water resources and ensuring a sustainable supply for agriculture, industry, and domestic needs in a changing climate. By promoting conservation techniques and discouraging wastage, the initiative seeks to build national resilience against water scarcity. This strategic effort is essential for protecting the environment.

185. (C) A is true but R is false.
A decentralized mechanism for the formal documentation of local biological resources and traditional knowledge serves as a vital tool for conservation and legal protection. Contrary to misconceptions, these registers are mandated by national law and have significant standing in protecting community rights. They help ensure that benefits from the use of resources are shared equitably and prevent unauthorized exploitation. By empowering citizens to participate in management, this system supports both biodiversity goals and social justice for future sustainability.

186. (B) Provide a financial incentive for reducing carbon emissions.
A market-based mechanism exists where tradable certificates represent the right to release a specific amount of greenhouse gases, providing a clear financial incentive for companies to reduce their environmental impact. By putting a price on emissions, the system encourages investments in cleaner technologies and sustainable practices. Entities that successfully lower their carbon footprint can sell their surplus permits to those who find it more difficult to make reductions. This approach facilitates global efforts to meet climate targets flexibly.

187. (D) Odisha

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to reduce overall intensity and greenhouse gas emissions. It targets large-scale industrial operations, commercial establishments, and residential buildings through various regulatory and market-based mechanisms. By encouraging the adoption of cleaner technologies and efficient practices, the initiative helps lower energy costs and enhances national energy security. This comprehensive approach is essential for achieving sustainable growth and meeting international commitments by optimizing how energy is consumed.

132. (A) Meeting current needs without compromising those of future generations.
In the context of environmental discussions, the term refers to the principle of meeting the developmental needs of the present without compromising the ability of future generations to meet their own requirements. This approach balances economic growth with social well-being and the long-term protection of the natural world. It emphasizes the rational use of resources and the preservation of ecosystem services that are essential for human survival. Achieving this goal requires a shift toward low-carbon energy.

133. (D) To understand the impacts of climate change on the Himalayan region.
A key objective of the specialized initiative is to gain a deeper scientific understanding of how climate change is impacting a sensitive mountain region. It focuses on monitoring glacial melt, assessing biodiversity loss, and studying the overall health of the ecosystem to inform better policy and management decisions. By generating reliable data and building local research capacity, the mission helps the country develop effective strategies for adaptation and resilience. This effort is vital for safeguarding critical water resources.

134. (B) Love Canal Disaster
A major environmental health crisis in a residential area was caused by the long-term leakage of hazardous substances from a former industrial waste site. The tragedy resulted in severe medical conditions among local families and highlighted the dangers of developing land that had been used for unregulated chemical disposal. This event became a catalyst for significant changes in environmental laws and the establishment of funds to clean up toxic sites. It emphasized the importance of monitoring industrial waste.

135. (C) A is true but R is false.
The ambitious national mission is dedicated to cleaning and rejuvenating one of the country's most significant river systems through pollution abatement and conservation. While various factors contribute to the river's degradation, the primary cause of severe pollution is the direct discharge of untreated industrial and domestic wastewater from urban and industrial centers. Effective restoration requires the implementation of robust sewage treatment infrastructure and strict regulations on industrial effluents. Understanding these major sources is essential for successful restoration.

136. (B) Providing subsidies for electric vehicles.
The national cleanliness campaign targets several key objectives to improve public health and hygiene across the country. It focuses on building millions of toilets for households and communities to end open defecation and promotes modern systems for municipal solid waste management. Additionally, the initiative aims to eradicate the practice of manual scavenging to ensure social dignity and safety. While the government has other programs to promote green transportation, such subsidies are not a direct component here.

137. (A) Save the Western Ghats forests from being cut down.
A grassroots movement in the state of Karnataka was organized by local villagers to prevent the commercial felling of trees in the sensitive Western Ghats region. Protesters used non-violent resistance, including hugging trees, to highlight the vital role that these forests play in maintaining water resources and local biodiversity. The movement successfully pushed for a ban on commercial logging in certain areas and encouraged the adoption of more sustainable forest management practices and environmental conservation.

138. (D) Statement I is incorrect but Statement II is correct.
Various health conditions arise from the long-term consumption of minerals found in

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124. (D) Integrated management of land and water resources.
Using a natural drainage area as a primary unit for planning is highly beneficial for the integrated management of land and water resources. This approach allows for a holistic understanding of how various activities impact the entire ecosystem, from the hills to the valleys. It facilitates effective soil conservation, groundwater recharge, and the sustainable use of natural resources within a logical geographical boundary. By moving beyond administrative borders, this method ensures that conservation efforts are ecologically sound for all.

125. (B) 1 and 3
The national climate action framework consists of eight specialized missions, each targeting a specific environmental goal. This set includes initiatives to rapidly expand solar power capacity and projects aimed at increasing forest cover to enhance biological carbon capture. While other government programs address issues like air quality or bio-energy, they may not be categorized as primary missions under this specific strategy. Understanding the exact components of this plan is important for tracking national progress toward international commitments.

126. (B) Environmental performance and sustainability.
The specialized rating system serves as a measure of how a building or infrastructure project performs in terms of environmental sustainability. It evaluates various criteria throughout the entire life cycle of the structure, including energy consumption, water efficiency, and the use of eco-friendly materials. A favorable rating indicates that the project has a lower ecological footprint and meets established national benchmarks for sustainable construction. This tool is essential for guiding developers toward creating more resource-efficient urban spaces.

127. (C) Bhopal
A catastrophic industrial tragedy occurred when a massive quantity of toxic gas leaked from a chemical facility located in a major central city. The incident caused immediate and widespread loss of life and led to chronic health issues for thousands of survivors over many decades. This disaster highlighted the severe risks associated with handling hazardous materials in proximity to dense residential areas. It remains a powerful symbol of the urgent need for global industrial safety standards and effective disaster management.

128. (A) Both Statement I and Statement II are correct.
Addressing the expansion of arid conditions involves the implementation of practices that prevent land degradation in vulnerable regions. Effective methods include large-scale tree planting and the sustainable management of livestock grazing to protect fragile vegetation cover. These efforts help stabilize the soil, improve moisture retention, and maintain the natural productivity of the landscape. By restoring the ecological balance, these measures reduce the risk of fertile areas becoming barren and support the resilience of rural communities.

129. (B) Odisha and Chhattisgarh
The disagreement over the sharing of water resources from a major eastern river system primarily involves two neighboring states. Tensions often arise concerning the construction of dams and the allocation of flow for agriculture and industry across state boundaries. Legal and political negotiations have been ongoing to find an equitable solution that balances the needs of both regions while protecting the river's ecological health. These conflicts illustrate the challenges of managing shared basins where growing demands frequently exceed supply.

130. (A) 1, 2 and 3
Managing the country's water resources involves various integrated strategies, such as capturing rainfall for later use and implementing national missions for conservation. Replenishing depleted underground aquifers through artificial recharge is also a critical component of ensuring a sustainable supply. While many programs focus on river cleaning, they are often part of broader conservation frameworks rather than being exclusively concerned with wetlands. Together, these efforts help build national resilience against water scarcity and ensure resources are available.

131. (C) The industrial, commercial, and residential sectors.
The national mission focuses on improving energy efficiency across multiple key areas

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conservation involves protecting vital habitats like wetlands and implementing integrated strategies for the restoration of degraded areas. By coordinating these diverse efforts, it is possible to maintain biological diversity and essential services for human well-being.

146. (A) Optimizing use of energy, water, and building materials.
An environmentally responsible structure is designed to maximize resource efficiency throughout its entire lifespan. This involves optimizing the use of energy, water, and sustainable building materials to minimize the overall ecological footprint. Such buildings often incorporate natural lighting, efficient waste management systems, and technologies that reduce carbon emissions. By following these principles, planners can create living and working spaces that are healthier for occupants and less damaging to the environment, aligning with national goals.

147. (D) Iodine
A significant public health issue involving the enlargement of the thyroid gland is most prevalent in geographic regions where the soil and water lack a specific essential mineral. This deficiency in the local environment leads to inadequate intake of the nutrient in the diet, affecting physical and neurological development. Public health strategies, such as the fortification of common table salt, have been highly successful in reducing the incidence of this condition and maintaining metabolic health in humans.

148. (C) Statement I is correct but Statement II is incorrect.
The iconic environmental campaign in the Himalayan region was famous for local communities using non-violent resistance to prevent commercial logging by embracing trees. While the movement originated in the state of Uttarakhand and achieved significant success in protecting the forest, it was not exclusively led by women, although they played a major role. These actions highlighted the deep connection between rural livelihoods and ecological conservation. The movement significantly influenced national policy and remains a global symbol of activism.

149. (B) GOI-UNDP Sea Turtle project
Among the various national conservation initiatives, one program is specifically dedicated to the protection of a marine species and its fragile nesting habitats along the coast. This project focuses on safeguarding the beaches where these animals arrive in large numbers to lay their eggs, particularly in regions like Odisha. By using modern monitoring technology and involving local communities, the program aims to ensure high hatching success and long-term population survival. Protecting these marine environments is essential for biodiversity.

150. (D) Afforestation and sustainable agricultural practices.
Combating the expansion of arid conditions involves the implementation of integrated land management strategies. Effective methods include large-scale afforestation to stabilize the soil and prevent further erosion, as well as the adoption of sustainable agricultural practices to maintain the natural productivity of the land. These efforts help restore the ecological balance and improve the landscape's ability to retain moisture. By implementing such measures, it is possible to prevent fertile areas from becoming barren and build regional environmental resilience.

151. (B) To improve the water quality of major rivers in the country.
The primary objective of the national framework for waterway protection is to improve the health and water quality of major rivers through pollution abatement measures. It focuses on intercepting and treating sewage and industrial effluents before they are discharged into the river systems. By coordinating efforts between central and state agencies, the program aims to restore the ecological integrity of degraded rivers and ensure they provide safe water. This integrated approach is vital for freshwater resource management.

152. (C) Catastrophic accidents at nuclear power plants.
Significant releases of radioactive material from power facilities have occurred due to catastrophic accidents, some triggered by natural disasters and others by technical failures. These events had widespread environmental and health impacts, leading to long-term contamination and global concern over energy safety. They serve as critical

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research, manufacturing, and the deployment of advanced technologies. It seeks to make solar power more affordable and accessible through various incentives and regulatory measures, such as creating large solar parks. By fostering innovation and investment in the renewable sector, the mission helps the country reduce its dependence on fossil fuels and achieve significant reductions in carbon emissions for security.

167. (B) Submergence of low-lying coastal areas and islands.
Rising ocean levels pose a direct and severe threat to low-lying coastal areas and islands, leading to increased flooding and the permanent submergence of land. This phenomenon can result in the loss of vital coastal ecosystems like mangroves and salt marshes, as well as the displacement of human populations. Additionally, higher sea levels can lead to the saltwater contamination of freshwater sources, further impacting security. Understanding these risks is essential for developing effective adaptation strategies for regions.

168. (A) Both Statement I and Statement II are correct.
A financial mechanism exists where tradable certificates represent the right to release a specific amount of greenhouse gases, providing a market-based incentive for companies to reduce their emissions. Entities that successfully lower their environmental impact can sell their surplus permits to those who find it more difficult to make reductions. This system creates a clear economic reward for adopting cleaner technologies. By putting a price on carbon, the policy encourages global efforts to achieve climate targets in a flexible manner.

169. (A) Long-term ingestion of high concentrations of fluoride, usually through drinking water.
The most common way people develop this chronic condition is through the long-term ingestion of high concentrations of fluoride, which often occurs naturally in deep groundwater sources. In affected regions, regular consumption of this contaminated water leads to permanent dental discoloration and, in more severe cases, debilitating skeletal deformities. Addressing this public health challenge requires a combination of providing alternative safe water supplies and implementing effective community-level filtration systems to protect vulnerable populations across hotspot regions.

170. (C) 1, 2, 3, 4, and 5
The national framework for addressing climate change is structured around several specialized missions, each targeting a distinct environmental or developmental goal. These initiatives cover key sectors such as solar power, energy efficiency, sustainable urban habitats, and water resource management. Additionally, a specific mission is dedicated to protecting the sensitive Himalayan ecosystem. By coordinating these diverse efforts under a single action plan, the country aims to achieve balanced growth while building resilience against impacts. This approach is essential for planning.

171. (D) Eutrophication and pollution.
The process of rehabilitating degraded water bodies focuses on reversing the negative effects of nutrient enrichment and chemical pollution. This involves implementing measures to reduce the inflow of nitrates and phosphates from surrounding agricultural and industrial areas, which are the primary causes of excessive algal growth. Additionally, physical and biological treatments may be used to restore water clarity and dissolved oxygen levels. Successful restoration helps recover natural biodiversity and ensures the lake can continue to provide essential services.

172. (B) The displacement of a large number of people.
The construction of a massive dam in a sensitive Himalayan region was highly controversial due to its location in a zone of high seismic activity and the significant social impacts it caused. A major point of contention was the large-scale displacement of local residents, including the submergence of an old town. Critics emphasized potential risks of structural failure and the loss of cultural heritage and livelihoods. These concerns underscore the complex ethical and environmental challenges associated with large-scale projects.

173. (C) Intercepting and treating domestic wastewater entering the river.
The primary goal of the dedicated river cleaning project is to improve the health of a major waterway by intercepting and treating domestic

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biological sinks that absorb greenhouse gases from the atmosphere. These healthy ecosystems not only help mitigate global warming but also support biodiversity and livelihoods. This strategic approach is a vital component of climate action, utilizing nature-based solutions.

160. (A) Both A and R are true and R is the correct explanation of A.
The national rating framework provides a comprehensive tool for assessing the environmental performance of buildings against established benchmarks. It evaluates various factors throughout the entire life cycle of a structure, including energy efficiency, water conservation, and the use of eco-friendly materials. By offering a standardized set of criteria, the system defines what constitutes a green building and helps developers create resource-efficient spaces. This tool is essential for promoting sustainable urban development and reducing the ecological footprint.

161. (B) Documenting local biological resources and traditional knowledge.
A decentralized mechanism for documenting local biological resources and the traditional knowledge associated with them serves as a vital tool for conservation and legal protection. It allows communities to maintain a record of their natural heritage and helps ensure that any benefits derived from its use are shared equitably with the local people. By formalizing this information at the local level, the register empowers citizens to participate in management and protects against unauthorized commercialization.

162. (B) Euro standards
The standardized regulations used to control air pollutants from motor vehicles in India are based on a widely recognized set of international frameworks. These norms are periodically made more stringent to reflect advancements in technology and more ambitious goals for urban air quality. By aligning national rules with these global standards, the government ensures that vehicles employ cleaner and more efficient engine designs. This approach is essential for reducing the environmental and health impacts of the transportation sector.

163. (C) Bauxite threatening a region rich in biodiversity and medicinal plants.
A significant environmental movement in the eastern region was driven by local opposition to a large-scale bauxite mining project in a sensitive hill range. Protesters were concerned that industrial activities would destroy the area's exceptional biodiversity, which is a rich source of medicinal plants and fresh water. The campaign emphasized the cultural and ecological significance of the landscape and highlighted potential long-term damage. This successful resistance demonstrated the importance of prioritizing ecological integrity over industrial expansion.

164. (A) Provide critical habitats for a wide variety of species and offer vital ecosystem services.
Fragile ecosystems like marshes and peatlands are vital for environmental health because they provide critical habitats for many species and offer essential services such as water filtration and flood control. These areas act as natural sponges that capture and slowly release water, helping to regulate the hydrological cycle. Furthermore, they are hotspots for biodiversity and support the livelihoods of many people. Protecting and managing these environments sustainably is essential for maintaining ecological balance and building climate resilience.

165. (A) P-3, Q-1, R-4, S-2
Various environmental crises and grassroots movements have shaped ecological policies across different regions and countries. Some historical disasters involving industrial pollution occurred in the East, while major dam projects and conservation campaigns emerged in the Himalayan region and southern evergreen forests. Mapping these events to their locations helps illustrate the diverse range of socio-environmental challenges and the unique local responses they generated. Understanding this history is vital for tracking the evolution of national and global environmental awareness.

166. (D) A policy framework that encourages research, manufacturing, and deployment of solar technologies.
The national initiative aims to rapidly expand clean energy capacity by providing a comprehensive policy framework that encourages

NODIA

reminders of the potential risks associated with nuclear power generation and have prompted international reviews of safety protocols and emergency management. Understanding these major crises is essential for developing safer energy policies globally.

153. (B) Water moves downward from surface water to groundwater.
The physical process involves the downward movement of water from the surface into the soil to replenish depleted underground aquifers. This can occur naturally through precipitation or be enhanced through artificial methods like building percolation tanks and check dams. By capturing excess runoff and allowing it to soak into the ground, these techniques help maintain a reliable water supply for agriculture and domestic use. Sustaining the levels of the water table is vital for building drought resilience.

154. (A) National Mission for Sustainable Agriculture
The specialized national initiative aims to protect the farming sector from the adverse impacts of climatic shifts by developing climate-resilient crop varieties and promoting integrated farming systems. It focuses on improving soil health, enhancing water use efficiency, and providing farmers with sustainable practices to maintain productivity despite unpredictable weather. By integrating these strategies into national agricultural policy, the mission seeks to ensure long-term food security and economic stability. This proactive approach is essential for adapting to environmental challenges.

155. (B) 1, 2 and 3
Major river projects across the country have faced significant opposition due to their varied and complex socio-environmental impacts. Issues range from the massive submergence of land and the displacement of indigenous communities to jurisdictional disputes over water sharing and concerns about building in seismically active zones. These conflicts highlight the difficult trade-offs between pursuing industrial development and protecting ecological integrity. Resolving these tensions requires transparent planning and equitable water-sharing agreements to ensure sustainable management of shared river basins.

156. (D) It disrupts ecosystem services that are essential for long-term human well-being.
The decline in the variety of life forms is a critical global issue because it weakens the ability of ecosystems to provide essential services that support human existence. Diverse biological systems are more resilient and are better at regulating climate, purifying water, and ensuring pollination for agriculture. When species are lost, these natural processes are disrupted, posing significant risks to long-term economic stability and human well-being. Protecting biodiversity is therefore fundamental for maintaining a healthy and habitable planet.

157. (B) Focus on cleanliness.
The primary goal of the massive national cleanliness campaign is to achieve universal sanitation coverage and create a cleaner environment for all citizens. It focuses on ending the practice of open defecation by building millions of household and community toilets and promoting modern systems for municipal solid waste management. By encouraging a national culture of hygiene and cleanliness, the program aims to significantly reduce the spread of diseases and improve overall public health outcomes.

158. (C) Statement I is correct but Statement II is incorrect.
Significant environmental movements in India have successfully challenged unsustainable development in fragile ecosystems. A notable campaign in the southern state of Kerala prevented a hydroelectric project from destroying a pristine tropical forest. In contrast, another grassroots initiative in Karnataka focused on stopping the commercial felling of trees through non-violent resistance. While these movements occurred in different regions, they both highlighted the vital role of community-led conservation in protecting biodiversity. Understanding their locations is essential for environmental history.

159. (D) Afforestation and improving the quality of forest cover.
The national mission focuses on enhancing the Earth's natural ability to store carbon by expanding and improving the quality of forest cover across the country. By undertaking large-scale afforestation and restoring degraded woodlands, the initiative creates significant

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wastewater before it enters the system. It focuses on building and modernizing sewage treatment plants and improving sanitation along the riverbanks to reduce pollution from urban centers. By addressing these significant sources of contamination, the program aims to restore the water quality and ecological character of the river for public health and biodiversity.

174. (D) It is a program focused solely on captive breeding in zoos.
The high-profile conservation program is dedicated to protecting a major apex predator and its natural habitats from extinction. It involves the creation of a vast network of reserves where populations can live and breed in the wild, which also helps preserve entire ecosystems. Contrary to misconceptions, the program is not focused on captive breeding in zoos; instead, it prioritizes scientific monitoring and anti-poaching measures. This comprehensive approach has become a global model for successfully safeguarding endangered species.

175. (A) 1, 2, 3, 4
Key environmental initiatives and industrial events have occurred in a specific historical sequence over the last several decades. The timeline began with the launch of major wildlife conservation programs, followed by a catastrophic industrial gas tragedy in the mid-1980s. Later, a comprehensive national framework was established to address global climate change. In the following century, another significant disaster at a power facility followed a massive natural event. Mapping these milestones helps in understanding the evolution of environmental policy.

176. (B) To conserve and manage soil and water resources within a natural drainage area.
The integrated management of land and water within a natural drainage area is a core strategy for environmental conservation and sustainable development. It focuses on soil and moisture conservation, groundwater recharge, and improving natural productivity through techniques like building check dams. By treating the entire basin as a single ecological unit, the approach ensures that resources are used judiciously and the risk of erosion is reduced. This holistic method is essential for supporting rural livelihoods and environmental health.

NODIA

177. (B) Arsenic
A chronic medical condition arises from the long-term ingestion of a specific toxic element, which often contaminates groundwater in certain river basins. Regular consumption of this water leads to the development of severe skin lesions and can cause significant damage to internal organs. This environmental health issue is a major challenge where communities depend on deep wells for drinking. Managing the problem requires providing alternative safe water sources and implementing effective filtration technologies to reduce the risk of poisoning.

178. (B) Both Statement I and Statement II are incorrect.
Environmental phenomena such as the thinning of the protective atmospheric layer and global warming have distinct chemical causes. The primary driver of ozone depletion is the release of specific man-made compounds used in cooling and aerosols, rather than common greenhouse gases like carbon dioxide. Similarly, climate change is caused by a variety of gases that trap heat in the atmosphere. Understanding these specific scientific differences is essential for developing targeted policies and international agreements that effectively address transboundary challenges.

179. (C) To assess the environmental performance of new buildings in India.
A specialized rating system was developed locally to measure the environmental performance of new buildings and infrastructure projects. It assesses various criteria such as energy consumption, water efficiency, and the use of sustainable building materials throughout the entire life cycle of a structure. By providing standardized benchmarks, the system helps developers and architects create projects that are tailored to the national context and have a lower ecological impact. This tool is essential for promoting sustainable urban habitats.

180. (B) 1, 2 and 4
Various health conditions are directly linked to environmental contamination or the lack of essential nutrients in the local diet. Some disorders result from an excess of certain

groundwater. One disorder is caused by an excess of fluoride in the water, leading to dental and skeletal deformities, rather than a deficiency. Another chronic condition results from prolonged exposure to high levels of arsenic, which can cause severe skin lesions and internal ailments. Understanding the specific causes and symptoms of these geological contaminations is vital for public health interventions, which include providing alternative safe water sources.

139. (D) Montreal Protocol.
The most successful global effort to protect the atmospheric shield against harmful radiation was the implementation of an international treaty that targeted the phase-out of specific man-made chemicals. This agreement led to a significant reduction in the use of substances common in refrigeration and aerosols, allowing the ozone layer to begin its long recovery process. It is widely considered a model for effective international environmental cooperation, demonstrating how global consensus can successfully address complex transboundary challenges effectively.

140. (B) P-3, Q-4, R-1, S-2
Various national programs and missions target specific environmental challenges across different sectors. Some focus on improving urban living through sustainable habitat standards and the use of specialized rating systems for buildings. Others implement rigorous norms for motor vehicle emissions to improve air quality, while major initiatives are dedicated to the rejuvenation of river systems and the expansion of forest cover. Mapping these concepts to their respective programs helps illustrate the comprehensive approach being taken toward national environmental sustainability.

141. (D) Mosquito-borne viral infection.
The primary health threat posed by this condition is that it is a serious viral infection transmitted to humans by specific types of mosquitoes. These insects typically breed in stagnant water found in and around urban residences, making the disease a significant public health concern in densely populated areas. Effective management requires a combination of community-led vector control efforts and public awareness campaigns to eliminate potential breeding sites. Understanding the nature of the virus is essential for prevention.

142. (B) Agricultural productivity and crop yields.
The stability of food supplies is deeply linked to climatic conditions because shifts in temperature and rainfall directly impact the productivity of crops. These variations can lead to lower yields, more frequent pests, and disrupted growing seasons, making it difficult for farmers to maintain consistent production. Such instability can result in food shortages and significant price fluctuations, particularly affecting the most vulnerable populations. Adapting agricultural systems and investing in climate-resilient technologies are essential for long-term food security.

143. (D) Address and mitigate the adverse impacts of climate change.
The national framework provides a comprehensive strategy to address the diverse challenges posed by a changing climate. It coordinates efforts across multiple sectors, including energy, water, agriculture, and forest management, to build national resilience and reduce greenhouse gas emissions. By implementing specialized missions, the plan seeks to promote sustainable development while adapting to environmental impacts. This strategic approach is essential for integrating climate considerations into all aspects of national policy and ensuring a balanced ecological response.

144. (A) The height of the dam and its effect on downstream water allocation.
A major disagreement over a large river project centers on the height of the dam wall and its impact on the volume of water available to downstream regions. This dispute between neighboring states has legal and political implications for water sharing and agricultural planning in the basin. Tensions often rise during periods of low rainfall when the allocation of scarce resources becomes even more critical. Resolving these issues requires transparent water-sharing agreements and cooperative management between states.

145. (B) 1, 2, 3, 4, and 5
Addressing environmental challenges requires a multi-faceted approach that covers both land and water resources. Issues like the loss of topsoil, the spread of arid conditions, and the nutrient enrichment of lakes all contribute to the decline of ecosystem health and productivity. Effective

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The national conservation project is particularly famous for its extensive work in the eastern state of Odisha to protect the massive nesting sites of sea turtles. Each year, thousands of female turtles migrate long distances to lay their eggs on these protected shores, a phenomenon of immense ecological importance. The project involves community-led monitoring and modern technology to safeguard nesting grounds from predators. Protecting these fragile populations is essential for maintaining global marine biodiversity and overall coastal health.

188. (B) Both Statement I and Statement II are incorrect.
Various national environmental initiatives target distinct ecological and public health challenges. A massive cleanliness campaign focuses on improving sanitation and waste management across the country, rather than being a forest conservation scheme. Similarly, a comprehensive mission for river rejuvenation is a dedicated program for pollution abatement and is managed as an independent project rather than being one of the missions under the climate action plan. Understanding specific program goals is essential for tracking progress toward universal sanitation and water sustainability targets.

189. (A) Improper disposal of toxic industrial waste.
A major environmental crisis occurred in a residential area due to the long-term leakage of toxic industrial substances from an old, unregulated disposal site. The tragedy resulted in widespread health problems among local families and became a powerful symbol of the dangers of improperly managed chemical waste. This event led to significant changes in national environmental laws and the establishment of funds to clean up hazardous sites. It emphasized the urgent need for rigorous monitoring of industrial disposal practices.

190. (D) P-3, Q-4, R-1, S-2
The national climate action framework consists of several specialized missions, each targeting a distinct environmental or developmental domain. These initiatives include projects to make farming more resilient to climatic shifts and programs dedicated to protecting sensitive mountain ecosystems. Additionally, there are efforts to improve energy efficiency in industrial and building sectors and to rapidly expand renewable energy capacity. Mapping these missions helps illustrate the comprehensive approach being taken to address environmental challenges through coordinated strategic actions.

191. (D) Building check dams and afforestation.
Addressing the expansion of arid conditions involves the implementation of integrated land and water management techniques. Effective methods include building small check dams to capture rainfall and undertaking large-scale afforestation to stabilize soil and prevent further erosion. These efforts help restore ecological balance and maintain landscape productivity in vulnerable regions. By improving moisture retention and protecting fragile vegetation, these measures reduce the risk of fertile land becoming barren and support the resilience of local communities.

NODIA

192. (B) Pollution abatement in rivers.
The primary challenge addressed by the national framework for protecting and restoring major waterways is the widespread pollution caused by domestic and industrial wastewater. The program implements various abatement measures, such as building and modernizing sewage treatment plants, to intercept contaminants before they reach the river systems. By focusing on improving water quality and ecological health, the plan aims to ensure that rivers can continue to support biodiversity and provide safe water for the environment and humans.

193. (C) Krishna
A major disagreement over water sharing and dam construction between several neighboring states involves the allocation of flow from a significant southern river system. The dispute centers on the height of the dam wall and the volume of water available for agriculture and industry in different regions of the basin. Legal and political negotiations have been ongoing to find an equitable solution that balances developmental needs while protecting river health. This conflict illustrates challenges in managing shared water resources.

194. (D) Encouraging the use of private transport over public transport.

Global environmental issues such as climate change are transboundary in nature and cannot be solved by any single nation acting alone. International cooperation through multilateral treaties and conventions is essential for establishing shared responsibilities and coordinating a collective response to these complex challenges. These efforts allow countries to align national policies with international standards and work toward common goals for protection. Understanding the necessity of this cooperative approach is vital for achieving significant progress in managing global environmental risks.

236. (B) The growth of toxic algal blooms that can harm humans.
A major environmental health concern associated with the excessive nutrient enrichment of water bodies used for drinking is the rapid growth of toxic algal blooms. These organisms can produce harmful substances that are difficult to remove and pose significant risks to human health. Exposure to these toxins can cause a range of medical conditions, from skin irritation to serious internal ailments. Managing the inflow of pollutants is essential for preventing these outbreaks and ensuring that water resources remain safe for domestic use.

237. (B) Chipko Movement
A grassroots movement in the southern state of Karnataka is culturally and philosophically linked to a famous Himalayan campaign for forest protection. Both initiatives were driven by local communities who used non-violent resistance to stop commercial logging and prevent the destruction of their natural resources. These movements highlighted the connection between rural livelihoods and biodiversity preservation. While they occurred in different regions, they shared a common goal of promoting sustainable forest management. These actions have been instrumental in shaping national ecological policies.

238. (A) Both Statement I and Statement II are correct.
The concept involves ensuring that a nation has a reliable and affordable supply of energy to meet its developmental and social needs. In the context of the global transition, achieving this goal increasingly requires a strategic shift toward renewable and low-carbon energy sources like wind and solar power. By diversifying the national energy mix, a country can enhance its economic stability while also mitigating its overall environmental impact. This approach is essential for achieving long-term sustainability and meeting international climate commitments.

239. (D) It has the world's largest mass nesting beach for Olive Ridley turtles.
The specialized conservation program focuses heavily on the eastern state of Odisha because it is home to the world's largest mass nesting beach for a specific marine species. Each year, thousands of female turtles migrate long distances to lay their eggs on these protected shores, a phenomenon of immense significance. The project involves community participation and modern monitoring techniques to safeguard the nesting grounds. Protecting these fragile sites is essential for the long-term survival of turtle populations and for maintaining marine biodiversity.

240. (C) P-3, Q-4, R-1, S-2
Various global environmental challenges have distinct characteristics and impacts on the planet. Some involve a significant reduction in the variety of life forms, while others are characterized by the thinning of the atmospheric shield against radiation. Additionally, there are processes that lead to the inundation of low-lying coastal areas and excessive enrichment of water bodies with nutrients. Understanding the specific definitions of these phenomena is essential for developing effective international policies. Mapping these issues helps illustrate the complex nature of ecological risks.

241. (D) To promote the conservation and wise use of wetlands.
The primary objective of the international treaty is to promote the conservation and wise use of wetlands of global importance for biodiversity. It encourages member nations to protect these fragile ecosystems, which provide essential services such as water filtration and flood control. By designating specific sites, countries commit to ensuring sustainable management and preventing degradation. This global framework is essential for maintaining ecological balance and building resilience against impacts.

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the deep conflicts between pursuing industrial development and protecting ecological and social integrity. Resolving these tensions requires transparent planning and equitable solutions to ensure safety.

201. (B) Building percolation tanks and check dams.
Managing limited water resources involves implementing techniques that capture rainfall and allow it to soak into the ground to replenish depleted underground aquifers. Effective methods include building small percolation tanks and check dams to reduce runoff and enhance natural infiltration of water into the soil. By sustaining the levels of the water table, these practices ensure a more reliable supply for agriculture and domestic use. This sustainable approach is a vital component of integrated water resource management.

202. (D) Mercury poisoning
A severe neurological condition was caused by the long-term consumption of seafood contaminated with a highly toxic heavy metal that had been discharged from an industrial facility into a bay. This disaster highlighted the dangers of chemical pollution and the process of biological magnification, where toxins become more concentrated as they move up the food chain. The tragedy led to changes in international laws and a global effort to monitor hazardous substances. It serves as a reminder for safety regulations.

203. (A) Increase the forest and tree cover and improve the quality of existing forests.
The specialized national initiative focuses on expanding forest and tree cover to enhance biodiversity and increase the capture of atmospheric carbon dioxide. It aims to restore degraded ecosystems and improve the quality of existing woodlands, which also supports the livelihoods of communities that depend on these resources. By strengthening ecological infrastructure, the mission plays a critical role in the country's overall climate strategy. This long-term effort is essential for maintaining healthy ecosystems and achieving sustainability goals.

204. (C) Localized soil pollution
Several environmental challenges are considered global because they have impacts that transcend national borders and require international cooperation to address effectively. These include climate change, the loss of biological diversity, and the thinning of the atmospheric protective layer. While other types of pollution can be severe, they are often confined to specific geographic areas and are primarily managed at the local level. Understanding the scale of these problems is vital for developing effective policies and international agreements.

205. (C) 1, 2 and 4
Significant environmental campaigns in India have occurred in response to different ecological threats, from the Himalayan tree-hugging protests to initiatives protecting southern evergreen forests and the Western Ghats. These grassroots movements have been instrumental in shaping national policy and increasing public awareness about protecting natural resources. While other major changes in agriculture have also occurred, they were primarily focused on increasing production. Recognizing the impact of these various actions is essential for understanding environmental history.

206. (D) Protect elephants, their habitat, and corridors.
A centrally sponsored initiative is dedicated to the long-term survival of wild elephants by protecting their natural habitats and critical migration corridors. It provides support to states for managing human-elephant conflicts and preventing poaching, ensuring that these mammals have sufficient space and resources to thrive. By maintaining the health of the forests they inhabit, the program also helps protect biological diversity. This comprehensive approach is vital for the conservation of one of the country's most significant species.

207. (B) Enrichment of water by nutrients like nitrates and phosphates.
The excessive enrichment of water bodies with nutrients like nitrates and phosphates leads to the rapid growth of algae, which can severely degrade the ecological health of the aquatic environment. This process often results from the runoff of fertilizers and the discharge of untreated wastewater. When the massive algal biomass eventually dies and decomposes, it consumes vast amounts of dissolved oxygen, leading to hypoxic conditions that harm aquatic

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Biological systems like growing forests act as significant sinks by absorbing the gas through photosynthesis and incorporating it into plant biomass. Conversely, technological methods can capture emissions from industrial sources and inject them into underground formations. Both forms of storage play a critical role in international climate strategies. Protecting existing woodlands and undertaking afforestation are essential for enhancing this natural capacity for sustainability.

249. (A) Contaminated deep aquifers, especially in the Gangetic plain.
A chronic medical condition arises from the long-term ingestion of groundwater containing high levels of a specific toxic element, which is widespread in certain deep aquifers found in river basins like the Gangetic plain. Regular ingestion of this contaminated water leads to severe skin lesions and internal damage over many years. This environmental health issue is a major challenge where communities depend on deep wells for drinking water. Managing the problem requires alternative safe water sources and effective filtration technologies.

250. (B) Address the challenge of climate change through a set of defined missions.
The national framework provides a comprehensive strategic approach to address the multi-faceted challenges of climate change through a set of eight defined missions. These initiatives target key sectors such as renewable energy, water security, sustainable habitats, and forest conservation to build national resilience and reduce overall greenhouse gas emissions. By coordinating these diverse efforts, the plan seeks to achieve balanced and sustainable growth while adapting to impacts. This strategy is essential for integrating climate considerations into all aspects of planning.

251. (B) Sea level rise
Sea level rise results from two primary physical mechanisms linked to global temperature increases. Thermal expansion occurs as water molecules move further apart when heated, increasing the volume of the oceans. Simultaneously, the melting of terrestrial ice, such as glaciers and polar ice sheets, adds substantial quantities of fresh water to the sea, further elevating global water levels.

252. (A) Anthropogenic greenhouse gas emissions
Global temperature changes and shifting precipitation patterns are predominantly fueled by the accumulation of greenhouse gases in the atmosphere. Human activities, such as burning fossil fuels and industrial processes, release these substances, creating a warming effect. This phenomenon alters the planetary climate system, resulting in more frequent extreme weather events and widespread environmental disruption across various continents.

253. (C) Ozone layer depletion
Protecting the stratosphere requires international cooperation to phase out harmful substances like chlorofluorocarbons. The Montreal Protocol is a global agreement specifically designed to curb the production of chemicals that destroy the ozone layer. While these efforts have successfully reduced emissions, the complete restoration of this atmospheric shield remains a long-term goal for the international scientific and environmental communities.

254. (D) environmental problems are often global in scope and cross national borders.
International environmental cooperation is essential because ecological crises do not respect political boundaries. Many significant challenges, such as global warming and widespread pollution, transcend individual nations and require a collective response. Fostering action through treaties and intergovernmental panels ensures that knowledge and resources are shared effectively, enabling a more comprehensive approach to managing threats that affect the entire planet.

255. (C) The success of the Montreal Protocol
Protecting the variety of life on Earth involves addressing multiple threats, including the destruction of natural habitats and the impacts of pollution. While factors like human-induced climate change accelerate biodiversity loss, international treaties like the Montreal Protocol actually focus on environmental protection and healing. Such successful global agreements are designed to mitigate environmental damage rather than contributing to the loss of species.

256. (B) National Mission on Strategic Knowledge for Climate Change

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is essential for achieving sustainable growth through innovative and cost-effective market-oriented solutions.

215. (A) P-3, Q-1, R-4, S-2
Major environmental and industrial catastrophes have occurred due to varied causes, ranging from catastrophic failures at nuclear facilities and toxic gas leaks to the consequences of improperly managed chemical waste. Some historical tragedies involved severe neurological poisoning from industrial discharges into coastal waters. Mapping these diverse events to their primary causes helps in understanding the wide range of technological and environmental risks. This knowledge is essential for developing more robust safety regulations and disaster response protocols worldwide.

216. (B) Documenting local biodiversity and associated traditional knowledge.
A decentralized mechanism for the formal documentation of local biological resources and traditional knowledge serves as a vital tool for conservation and protecting community rights. These records help ensure that any benefits derived from the use of such resources are shared equitably and prevent unauthorized exploitation. By formalizing this information at the local level, the system empowers citizens to participate in environmental management and protects indigenous wisdom. This approach supports both national biodiversity goals and social justice for sustainability.

217. (B) Making agriculture more resilient to climate variability and change.
The national mission aims to transform the agricultural sector by making it more resilient to the impacts of climatic variations and shifting weather patterns. It focuses on promoting sustainable farming practices that improve soil health, enhance water use efficiency, and utilize climate-resilient crop varieties to maintain productivity. By integrating these strategies into national policy, the mission seeks to ensure long-term food security and protect livelihoods. This proactive approach is essential for adapting to the challenges posed by changing environments.

218. (A) Both Statement I and Statement II are correct.
The expansion of desert-like conditions is a significant form of land degradation that can be caused by both climatic variations and human activities. Factors like unsustainable farming practices, the removal of forest cover, and the management of livestock grazing can strip the land of its natural productivity. These processes can turn fertile regions into barren landscapes unable to support agriculture. Implementing integrated management strategies is essential for restoring ecological balance and preventing the further degradation of fragile semi-arid regions.

219. (C) Environmentally responsible and resource-efficient throughout its life-cycle.
An environmentally responsible structure is designed and operated to maximize resource efficiency throughout its entire life cycle. This involves optimizing the use of energy, water, and sustainable materials to minimize ecological footprint and reduce waste. Such buildings often incorporate natural ventilation and modern technologies to lower their environmental impact. By following these principles, planners can create urban spaces that are more resilient to climate change and support broader national sustainability goals for the future.

220. (B) 1, 2, 3 and 5
Various health conditions arise from the consumption of contaminated water or the lack of essential minerals in the local environment. Some chronic disorders lead to dental and skeletal deformities due to high levels of specific elements, while others are linked to nutritional deficiencies in soil and water. Additionally, the discharge of toxic heavy metals can cause severe neurological syndromes. Understanding these complex links between health and geological contamination is vital for public health interventions to protect vulnerable populations.

221. (A) Protect a pristine evergreen forest from a hydroelectric project.
A successful environmental campaign was organized to protect a unique tropical forest in the southern state of Kerala from being submerged by a proposed power facility. The area is renowned for its exceptional biodiversity and serves as a critical habitat for many rare species. Activists successfully argued that the ecological value of the pristine environment far

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The concept of creating environmentally friendly living environments involves a multi-faceted approach, including green building standards and efficient waste management. It also emphasizes improving energy efficiency in urban infrastructure and encouraging the use of sustainable public transportation to reduce the overall carbon footprint. By integrating these goals into city planning, the initiative aims to create liveable and resource-efficient habitats. This holistic approach is essential for building resilience against climate change and ensuring sustainable development in increasingly urbanized areas.

195. (D) All of the above
Various national environmental initiatives and grassroots movements play critical roles in protecting biodiversity, restoring natural resources, and improving public health. These include high-profile programs for species conservation, massive campaigns for universal sanitation, and strategic missions for expanding renewable energy capacity. Additionally, historical grassroots actions have successfully challenged unsustainable development in fragile ecosystems. Together, these diverse efforts form a comprehensive framework for addressing environmental challenges and promoting sustainable development at all levels of society for future generations.

196. (B) Climate change can disrupt agricultural production, leading to food shortages and price volatility.
Shifts in global temperature and rainfall patterns directly threaten the stability of food systems by disrupting agricultural production and reducing overall crop yields. These climatic variations can lead to more frequent and intense droughts, floods, and pests, making traditional farming less predictable. Such instability can result in food shortages and significant price volatility, particularly affecting vulnerable populations who have the least capacity to adapt. Developing climate-resilient crop varieties is an essential step to ensure consistent access.

197. (B) Silent Valley Movement
A significant environmental campaign was organized in the southern state of Kerala to protect a unique tropical evergreen forest from being submerged by a proposed power generation facility. The area is renowned for its exceptional biodiversity and serves as a critical habitat for many rare species found in the Western Ghats. Activists successfully argued that the ecological value of the pristine environment far outweighed the benefits of the project. This landmark victory demonstrated the importance of prioritizing conservation over industrial development.

198. (D) Statement I is incorrect but Statement II is correct.
A decentralized mechanism for documenting local biological resources and traditional knowledge is a vital tool for conservation and protecting community rights. These records help ensure that benefits from the use of such resources are shared equitably and prevent unauthorized exploitation. While they are important for research, their primary purpose is to empower communities and provide a legal framework for protecting natural heritage. By formalizing this information, the system supports biodiversity goals and ensures that indigenous wisdom is preserved.

199. (D) Gharial
The national conservation initiative for large reptiles focuses on protecting three native species, including a unique long-snouted variety that primarily feeds on fish. This specialized project involves breeding and management programs to revive dwindling populations and protect natural freshwater habitats. By establishing sanctuaries and conducting research, the program aims to prevent the extinction of these ecologically significant animals. This comprehensive approach addresses specific species needs while managing potential conflict with human communities in shared landscapes for environmental sustainability.

200. (D) Large-scale submergence of forests and displacement of tribal communities.
A major river project faced intense socio-environmental criticism due to the massive changes it caused in the landscape, including large-scale submergence of natural forests and agricultural land. Furthermore, the construction of massive dams led to the displacement of many tribal communities who had lived on the land for generations. These impacts highlight

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expand solar power capacity and projects aimed at enhancing energy efficiency both contribute to the overall goal of climate change mitigation. Understanding the integrated nature of these missions is essential for tracking national progress toward international commitments.

229. (D) Restoring ecosystem services and improving agricultural productivity.
Restoring the quality and natural productivity of degraded land is essential for ecological health and human well-being. This process involves implementing conservation measures that rebuild soil health, stabilize landscapes, and restore essential ecosystem services such as carbon capture. By transforming barren areas back into functional ecosystems, these efforts support biodiversity and enhance agricultural productivity. Successful reclamation is vital for ensuring food security and building environmental resilience, as it reduces the loss of fertile land and helps communities adapt.

230. (B) 1, 2 and 3
Standardized regulations are implemented to control the release of various air pollutants from internal combustion engines to improve urban air quality. These norms are periodically updated to reflect advancements in clean engine technologies and are progressively made more stringent. The rules apply to all types of motor vehicles to ensure a comprehensive reduction in the environmental impact of the transportation sector. Following these standards is essential for protecting public health and reducing the concentration of harmful substances in the atmosphere.

231. (B) To achieve pollution abatement and rejuvenation of the Ganga river.
The primary goal of the massive national mission is to achieve the effective abatement of pollution and the rejuvenation of a major river system through integrated conservation measures. It focuses on building sewage treatment infrastructure, managing industrial effluents, and restoring the natural biodiversity of the waterway to bring water quality back to acceptable standards. By addressing significant sources of contamination, the program aims to ensure long-term ecological health. This effort is vital for protecting public health and cultural significance.

232. (C) National Mission on Biodiversity and Human Well-being
The national climate action framework is structured around eight specialized missions that target key areas such as renewable energy, water security, and the protection of sensitive mountain ecosystems. While many other programs address critical issues like biological diversity, they are managed through different government frameworks rather than being listed as one of the specific primary missions under the climate action plan. This distinction helps in understanding how various national goals are organized. Each specialized mission plays a unique role in building resilience.

233. (A) Bauxite and medicinal plants.
A significant hill range in the eastern region is renowned for being a rich repository of both valuable minerals and a diverse array of medicinal plants. The area's exceptional biodiversity makes it a vital resource for the local indigenous population. Environmental movements emerged in the region to protest against large-scale mining projects that threatened to destroy these natural resources and disrupt the ecological balance. Protecting this landscape is essential for maintaining biological heritage and ensuring that developmental activities do not compromise environmental integrity.

234. (D) Increasing vegetation cover and practicing contour ploughing.
The most effective way to address the removal of topsoil by physical forces is to implement conservation practices that increase vegetation cover and stabilize the land. Techniques like contour ploughing and building terraced fields help slow down water runoff and prevent the soil from being washed away. Additionally, planting trees and maintaining ground cover provide natural barriers against erosion. These efforts help rebuild soil health and maintain productivity for agriculture. Managing land sustainably is essential for ensuring long-term food security.

235. (A) Both A and R are true and R is the correct explanation of A.

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outweighed the project benefits, leading to its eventual cancellation. This landmark victory demonstrated the power of community action in protecting natural heritage.

222. (D) The Ganga Action Plan
The national framework for protecting and restoring major waterways emerged from an earlier initiative that targeted the pollution of one of the country's most significant river systems. This original plan provided a template for addressing widespread contamination through pollution abatement measures like building sewage treatment infrastructure. By expanding the scope of this integrated approach to other rivers, the government aims to restore water quality across the country. This evolution illustrates the growing national commitment to managing freshwater resources sustainably.

223. (B) Nuclear accident
A catastrophic failure at a power facility in the mid-1980s is a prime example of a major accident involving the release of massive quantities of radioactive material. This disaster had widespread environmental and health consequences, affecting large parts of a continent and leading to long-term contamination. The event served as a critical turning point for global energy policy, highlighting risks associated with nuclear power and prompting reviews of safety standards. Understanding such crises is essential for safer strategies.

224. (A) Designating them as Ramsar sites.
Identifying specific areas of global significance for biodiversity as protected sites under an international treaty is a key strategy for the conservation of wetlands. By designating these habitats, countries commit to ensuring sustainable management and protecting essential services such as water filtration and flood control. These areas act as natural sponges and are critical habitats for many species of migratory birds. Protecting and managing these fragile environments is essential for maintaining global ecological balance and building climate resilience.

225. (A) 4, 1, 3, 2
Key national environmental programs and wildlife conservation initiatives have been launched in a specific historical sequence over the last several decades. The timeline began with major efforts to protect apex predators, followed by specialized projects for large land mammals. Later, a comprehensive national framework was established to address the multi-faceted challenges of climate change. More recently, a massive campaign for universal sanitation was introduced to improve public health and hygiene. Mapping these milestones helps in understanding the evolution of environmental policy.

226. (B) The ability of human and natural systems to cope with or adjust to climate change.
The concept focuses on the ability of human and natural systems to adjust to current or anticipated changes in the environment to minimize potential damage. It involves implementing strategies such as building resilient infrastructure, developing climate-resilient crop varieties, and improving disaster management protocols. While mitigation seeks to address the causes of environmental change, this approach ensures that society can effectively manage impacts. Successful implementation requires integrated planning across various sectors to maintain social stability and support sustainable growth.

227. (C) National River Conservation Plan
Various river cleaning projects are part of a broader national framework designed to improve the health and water quality of major waterways through pollution abatement. This program coordinates efforts between central and state agencies to intercept and treat domestic and industrial wastewater before it enters the river systems. By focusing on habitat restoration and waste management, the initiative aims to bring water quality back to acceptable standards. This integrated strategy is essential for ensuring the sustainable management of precious freshwater resources.

228. (D) Statement I is incorrect but Statement II is correct.
The national framework for addressing climate change consists of eight specialized missions that target different aspects of sustainability and resilience. These initiatives are not completely independent; they share overlapping objectives, such as reducing carbon emissions and improving resource efficiency. For example, efforts to

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Protecting these environments is fundamental for a sustainable foundation.

242. (B) Create a knowledge system to support policy-making and action on climate change.
A major objective of the specialized initiative is to build a vibrant and dynamic knowledge system to support national policy-making on climate change. It focuses on strengthening research infrastructure and fostering collaboration between scientific institutions to generate reliable data and sophisticated climate models. By making this scientific information more accessible, the mission helps the country develop informed strategies for adaptation and mitigation. This effort is essential for ensuring that the response to environmental challenges is grounded in the best available science.

243. (C) A major earthquake and the subsequent tsunami.
The catastrophic failure and massive release of radioactive material from a nuclear facility followed a massive offshore earthquake and the subsequent powerful wave that overwhelmed its safety systems. This crisis highlighted the risks associated with building infrastructure in coastal areas prone to extreme natural events. The disaster prompted a reassessment of energy safety standards and emergency management protocols, emphasizing the need for robust designs. Understanding the causes of this major event is essential for developing safer energy policies and disaster response.

244. (D) Geographical location.
While both grassroots movements share a common philosophy of non-violent resistance and a goal of protecting trees, their primary difference lies in their geographical location. One campaign originated in the Himalayan region of a northern state to challenge logging in mountain ecosystems. In contrast, the other initiative emerged in the southern state of Karnataka to protect the unique biodiversity of the Western Ghats. These parallel movements demonstrate the power of community-led conservation across different ecological zones and highlight widespread national environmental consciousness.

245. (C) 1, 2, 3, 4, and 5
Major river projects across the country have faced significant and varied socio-environmental controversies. These issues range from the massive submergence of land and displacement of local populations to complex jurisdictional disputes over water sharing among states. Additionally, concerns have been raised about the ecological impact and safety risks of building large infrastructure in seismically active mountain zones. Together, these examples illustrate the difficult trade-offs between pursuing industrial development and protecting ecological integrity. Resolving these tensions requires transparent planning and rigorous assessments.

246. (B) Make cities more sustainable through improvements in energy efficiency, waste management, and transport.
The primary goal of the specialized national mission is to create more environmentally friendly and resilient urban areas by integrating energy efficiency into building codes and city planning. It also focuses on improving municipal systems for waste management and promoting sustainable public transportation to reduce the overall urban carbon footprint. By encouraging the adoption of green building standards, the initiative aims to create liveable habitats. This approach is essential for achieving sustainable development in urbanized regions and reducing environmental pressure.

247. (B) Increasing the population of the Greater One-horned Rhinoceros in Assam.
A dedicated conservation program aims to increase the wild population of the greater one-horned rhinoceros by expanding its range across multiple protected sanctuaries in the northeastern state of Assam. By strategically relocating animals, the initiative reduces risk of population loss due to habitat destruction or disease. This effort involves strengthening management practices and improving the quality of habitats to ensure the long-term survival of the species. The program is a significant milestone, demonstrating how coordinated government action can effectively protect wildlife.

248. (A) Both Statement I and Statement II are correct.
The long-term storage of atmospheric carbon dioxide to help mitigate global warming involves both natural and engineered processes.

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life. Managing these inputs is essential for restoring water quality.

208. (D) Statement I is incorrect but Statement II is correct.
A dedicated river conservation program focuses on improving the health of a major waterway by implementing measures to reduce pollution from domestic and industrial sources. While the initiative involves collaboration with international partners for funding, it is a national project primarily aimed at restoring water quality within the country. The plan focuses on building sewage treatment infrastructure and improving sanitation along the riverbanks to ensure a cleaner environment. Understanding specific objectives is essential for tracking progress toward river rejuvenation.

209. (A) National Mission for Sustainable Habitat
A specialized rating framework is an integral component of the national mission that targets the creation of more environmentally friendly and resource-efficient urban areas. It provides a standardized set of benchmarks for assessing the environmental performance of buildings and infrastructure projects throughout their life cycle. By encouraging the adoption of green building standards, the mission aims to reduce the overall carbon footprint of growing cities. This tool is essential for guiding developers toward creating habitats that are resilient to climate change.

210. (A) Both A and R are true and R is the correct explanation of A.
A catastrophic industrial accident in a central city was caused by the massive leak of a highly toxic gas from a chemical facility, resulting in widespread immediate and long-term health complications. The tragedy highlighted the severe risks associated with the storage of hazardous materials in proximity to dense residential areas. It remains a powerful symbol of the urgent need for stringent industrial safety standards and effective disaster response protocols to protect public health. This event fundamentally changed risk management.

211. (D) To eliminate open defecation and improve solid waste management.
The primary goal of the massive national cleanliness campaign is to improve public health by ending the practice of open defecation and implementing modern systems for municipal solid waste management. It focuses on achieving universal sanitation coverage through the construction of millions of household toilets and promoting a culture of cleanliness. By reducing the spread of diseases and enhancing dignity, the initiative aims to create a cleaner environment across both rural and urban areas.

212. (B) The ecological fragility and seismic vulnerability of the region.
Large-scale power projects in high mountain regions often face intense criticism due to the inherent geological fragility and high seismic vulnerability of the landscape. Constructing massive infrastructure in these areas can significantly increase the risk of landslides and other natural disasters, threatening both the environment and local communities. Additionally, these projects can disrupt sensitive mountain ecosystems and affect traditional livelihoods. These concerns emphasize the need for rigorous impact assessments and the consideration of sustainable alternatives.

213. (C) Carbon sequestration
The process of capturing and storing atmospheric carbon dioxide in a stable form is a vital strategy for mitigating the effects of global warming. This can occur naturally through biological systems like forests and oceans, which act as significant sinks for greenhouse gases, or through engineered technologies. By reducing the concentration of carbon in the atmosphere, these methods play a critical role in international climate efforts. Enhancing these sinks is essential for achieving long-term sustainability and balancing the carbon cycle.

214. (D) Perform, Achieve and Trade (PAT)
A key component of the national mission for improving energy efficiency is a market-based mechanism that incentivizes large-scale industrial consumers to reduce energy intensity. This program involves setting specific consumption targets for energy-intensive sectors and allowing those that exceed their goals to trade energy saving certificates. By creating a clear economic reward for efficiency improvements, the initiative helps lower overall costs and reduces environmental impact. This approach

Creating effective climate policy requires a robust foundation of scientific knowledge and reliable data systems. Within the strategic framework of national action plans, certain missions are dedicated to building this expertise. These initiatives foster research and development in climate science to ensure that policy decisions are grounded in evidence. Such efforts are crucial for navigating the complex challenges posed by global warming.

257. (D) National Mission for Sustainable Agriculture
Ensuring food security in a changing environment involves making farming systems more resilient to shifting weather patterns. Strategies for sustainable agriculture focus on adapting to climatic variations to maintain productivity and support livelihoods. By integrating resilience into agricultural practices, nations can safeguard their food supplies against the detrimental effects of rising temperatures and unpredictable rainfall, which are becoming increasingly common today.

258. (A) Urban planning, energy efficiency in buildings, and waste management
Promoting urban sustainability involves integrating energy efficiency and responsible waste management into the built environment. This focus ensures that human habitats are designed and managed to reduce their ecological footprint. Strategies targeting building designs and infrastructure help improve overall resource use within cities. These measures are vital for fostering sustainable development and addressing the environmental challenges associated with rapid and widespread urbanization.

259. (C) National Mission for a 'Green India' – Reforestation and ecological restoration
Ecological restoration involves active efforts like reforestation to repair damaged landscapes and enhance biodiversity. Programs focused on a greener environment prioritize these activities to restore natural functionality to ecosystems. By planting trees and stabilizing habitats, these initiatives help mitigate the impacts of environmental degradation. Such efforts are essential for maintaining the ecological balance and ensuring the long-term health of national forests.

260. (A) integrate climate adaptation and mitigation into the national development strategy.
National strategic frameworks aim to unify climate change adaptation and mitigation with the broader process of development. This holistic approach ensures that environmental concerns are not addressed in isolation but are woven into the fabric of national planning. By balancing economic goals with the need for sustainability, these plans provide a comprehensive roadmap for addressing multifaceted environmental crises while promoting long-term growth.

261. (D) location in a seismically active region.
Large infrastructure projects in mountainous regions face specific environmental risks related to geological stability. The construction of massive dams in areas prone to earthquakes raises significant concerns regarding potential disasters and ecological disruption. These projects must carefully evaluate the seismic activity of their locations to ensure safety and minimize the impact on surrounding communities and the delicate balance of the high-altitude ecosystem.

262. (B) disputes over interstate water sharing.
Managing water resources often leads to complex disputes between different regions or states sharing the same river system. These conflicts typically arise over the allocation and distribution of water for agricultural and industrial needs. Negotiating these shared resources is a persistent challenge, as each party seeks to secure its water supply, often leading to prolonged legal and social tensions between the riparian states.

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263. (C) The conflict between providing clean energy and incurring significant environmental trade-offs.
Developing hydropower in sensitive ecological regions creates a significant dilemma between the need for clean energy and the preservation of nature. While these projects offer renewable power, they often lead to deforestation, habitat loss, and disruption of river ecosystems. Finding a balance between meeting energy demands and protecting local biodiversity requires careful consideration of the environmental trade-offs involved in such infrastructure projects.

264. (D) controversies related to community displacement and submergence of forests.

vital for a nation's overall security. By integrating land reclamation with these wider goals, societies can build greater resilience against climate change while fostering a more sustainable and secure future.

281. (A) The Chipko movement
Many grassroots environmental movements share a similar philosophy of non-violent protest against the commercial exploitation of forests. These campaigns often emphasize the deep connection between local livelihoods and the health of the natural environment. By using similar strategies to prevent the felling of trees, these movements highlight a widespread commitment to protecting biodiversity and promoting sustainable resource management at the local level.

282. (B) save a tropical evergreen forest from a hydroelectric project.
Campaigns to protect pristine forest areas often emerge in response to proposed industrial or energy projects that threaten biodiversity. These successful movements emphasize the importance of preserving ecologically sensitive regions from being submerged or destroyed. By focusing on the intrinsic value of evergreen forests, such struggles highlight the need to prioritize ecological health over short-term developmental gains in various biological hotspots.

283. (B) To formally document local biodiversity and associated traditional knowledge.
Formal documentation of local biological resources and traditional knowledge is a vital tool for community empowerment. This systematic recording allows local populations to manage and use their natural heritage sustainably while protecting it from exploitation. By institutionalizing this knowledge, communities can better conserve biodiversity and ensure that their traditional practices are recognized and integrated into broader environmental management strategies.

284. (A) The proposal for bauxite mining
Local communities often lead struggles to protect lands they consider sacred or essential for their survival from industrial activities like mining. These movements arise when projects threaten to destroy precious resources such as medicinal plants or clean water. Such conflicts underscore the tension between large-scale economic development and the rights of local people to protect their natural environment.

285. (C) active role of local communities in protecting their environment and livelihoods.
A recurring theme in many environmental struggles is the active participation of local people in defending their surrounding ecosystems and livelihoods. These movements demonstrate how communities can effectively challenge activities like deforestation or mining that threaten their well-being. By taking a stand, local citizens highlight the essential role of grassroots action in achieving environmental protection and ensuring the sustainable use of natural resources.

286. (D) Project Elephant
Dedicated conservation programs focus on protecting the natural habitats and migratory paths of large keystone species. These initiatives aim to ensure the long-term survival of animal populations by addressing threats such as habitat loss and human-wildlife conflict. By securing the landscape and corridors these animals use, these projects help maintain healthy populations and preserve the ecological integrity of the regions they inhabit.

287. (C) increasing the rhino population and distributing them across protected areas.
Ambitious wildlife initiatives aim to increase the numbers of endangered species and ensure their long-term viability by expanding their range across multiple protected areas. This strategic distribution helps mitigate the risks of localized threats and improves the genetic diversity of the population. Such efforts are critical for the recovery of iconic species and the overall success of national biodiversity conservation goals.

288. (B) captive breeding and subsequent release into the wild.
Conservation strategies for endangered reptiles often involve specialized programs like breeding animals in controlled environments before returning them to their natural habitats. This approach helps boost dwindling populations and ensures that young animals have a better chance of survival. By combining captive breeding with habitat protection, these projects work to restore

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Nutrient enrichment in water bodies causes a significant decline in water quality through a process that fuels excessive algal growth. This phenomenon leads to the depletion of dissolved oxygen, which is critical for the survival of aquatic life. Often resulting from agricultural runoff or sewage, this degradation makes lakes and ponds less hospitable to native species and compromises their ecological functions.

273. (D) wetlands.
International treaties provide a framework for the conservation and sustainable use of vital ecosystems known as wetlands. These areas provide numerous ecological services, such as water filtration and habitat for diverse species. By becoming signatories to such conventions, nations commit to maintaining the ecological character of these sites, ensuring they are managed wisely to benefit both the environment and local communities.

274. (A) the holistic rejuvenation and cleaning of the river Ganga.
Revitalizing major river systems involves holistic efforts that combine cleaning activities with the long-term management of the surrounding ecosystem. Comprehensive programs focus on reducing pollution and restoring the natural flow and health of the water. This integrated approach ensures that rivers can continue to provide essential services and support biodiversity, reflecting a deep commitment to environmental restoration and sustainable resource management.

275. (C) excessive growth of algae and depletion of oxygen.
High levels of nutrients in water bodies often trigger the rapid and excessive growth of algae. This process consumes significant amounts of dissolved oxygen, creating an environment that is detrimental to fish and other aquatic organisms. Such degradation not only harms local biodiversity but also reduces the clarity and overall health of the water, making restoration efforts essential for ecological recovery.

276. (A) In arid, semi-arid, and dry sub-humid areas
Land degradation in specific climates, such as arid or semi-arid regions, can lead to a severe loss of biological productivity. This process, often driven by a combination of human activities and climatic variations, results in the expansion of desert-like conditions. Managing these fragile environments requires sustainable practices that protect vegetative cover and ensure the long-term viability of the land for the resident populations.

277. (D) Afforestation and stabilizing sand dunes
Restoring the ecological functionality of degraded landscapes involves various reclamation techniques. Activities like planting trees to create forests and stabilizing shifting sand dunes help to halt further damage and improve soil stability. These measures are essential for rebuilding the productive capacity of the land, protecting local ecosystems from erosion, and supporting the livelihoods of communities that depend on healthy soil.

278. (B) agents like water and wind.
The removal and transportation of topsoil is primarily driven by natural agents like moving water and strong winds. This process reduces the fertility of the land and can lead to significant agricultural losses. Understanding these mechanisms is crucial for implementing conservation measures, such as maintaining vegetative cover or building physical barriers, to protect the soil and ensure its long-term productive capacity.

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279. (C) exacerbating the problems and making adaptability a key concern.
Shifting weather patterns and rising temperatures significantly worsen the challenges associated with soil erosion and desertification. These changes make the land more vulnerable to degradation, requiring more robust adaptation strategies. Addressing these interconnected issues is essential for maintaining sustainability, as climate change intensifies the pressure on natural resources and necessitates a more proactive approach to land management and ecological protection.

280. (D) energy security, food security, and sustainability.
Combating land degradation is intrinsically linked to broader objectives like ensuring reliable access to food and energy. Sustainable land management practices help maintain agricultural productivity and protect ecosystems, which are

Massive water resource projects can trigger significant social and environmental controversies. These often involve the displacement of large numbers of people from their ancestral lands and the flooding of valuable forests and agricultural areas. Balancing the benefits of such infrastructure with the human and ecological costs remains a profound challenge for developers and policy makers, highlighting the need for equitable and sustainable solutions.

265. (A) They all highlight the tension between development goals and environmental/social costs.
Infrastructure development frequently creates tension between national priorities and the potential for social and environmental harm. Whether through dam construction or mining, these projects often lead to community displacement and ecological damage. This central conflict highlights the difficult task of pursuing development goals like water and energy security while simultaneously upholding the principles of environmental protection and social justice for all.

266. (B) The integrated management of land and water resources within a drainage basin.
Managing land and water resources within a specific drainage area is a core principle of sustainable landscape management. This integrated approach focuses on conserving moisture, preventing soil erosion, and enhancing the productivity of the entire basin. By treating the area as a holistic unit, watershed development improves water availability and supports the ecological balance, ensuring that both land and water are used efficiently.

267. (B) rainwater harvesting.
Capturing and storing precipitation from various surfaces is a vital strategy for managing water scarcity. This technique involves collecting runoff from rooftops and open areas to be used for domestic or agricultural purposes instead of letting it go to waste. Such conservation practices are essential for augmenting available water supplies and promoting long-term water security, particularly in regions with highly variable rainfall.

268. (A) By artificially increasing the amount of water seeping into aquifers.
Augmenting groundwater levels is achieved by facilitating the seepage of surface water into underground aquifers. This process helps replenish vital water stores that are often depleted by excessive extraction. Techniques like constructing percolation pits and check dams slow down runoff, allowing more time for infiltration. Maintaining healthy aquifer levels is crucial for ensuring a reliable water supply and supporting the overall hydrological balance.

269. (C) Building percolation pits and check dams.
Effective groundwater management includes specific physical interventions designed to slow down surface runoff and promote soil infiltration. Constructing features like percolation pits and check dams allows water to collect and gradually seep into the ground, replenishing aquifers. These methods are essential for managing water resources sustainably, especially in areas where groundwater is a primary source for agriculture and human consumption.

270. (D) mitigate water scarcity and ensure long-term water security.
Strategies such as managing watersheds and harvesting rainwater are primarily intended to address the growing challenge of water scarcity. These techniques focus on the conservation and efficient use of existing resources to ensure that water remains available for the future. By implementing these practices, communities can build resilience against drought and maintain the ecological health of their surrounding natural environments.

271. (C) National River Conservation Plan.
National initiatives for river conservation coordinate various action plans to improve the water quality of major river systems. These programs integrate efforts across different regions to clean polluted waters and restore aquatic ecosystems. By managing river health holistically, such frameworks address the multiple sources of contamination, aiming to rejuvenate these vital waterways and protect the biodiversity that depends upon them for survival.

272. (B) The nutrient enrichment of a water body leading to degraded quality.

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species to the wild and secure their ecological future.

289. (D) the conservation of marine turtles and their nesting sites.
Protecting marine wildlife requires collaborative efforts that focus on safeguarding critical areas like nesting sites on beaches. These initiatives aim to reduce threats from human activities, such as fishing and coastal development, which can impact the survival of sea creatures. By working together, international and national organizations can implement more effective measures to conserve marine biodiversity and ensure healthy ocean ecosystems.

290. (A) They both focus on in-situ conservation by protecting natural habitats.
Flagship wildlife programs often share a focus on protecting species within their natural environments by establishing networks of dedicated reserves. This in-situ approach addresses major threats like poaching and habitat degradation while managing human-wildlife conflict. By securing the ecosystems where these animals naturally live, such initiatives provide a comprehensive framework for the long-term survival of a nation's most iconic animals.

291. (C) To act as a market-based mechanism that incentivizes emission reductions.
Financial incentives for reducing carbon emissions can be created through market-based mechanisms where rights to emit greenhouse gases are traded. This system rewards organizations that successfully lower their carbon footprint by allowing them to sell their excess capacity to others. Such economic tools are designed to encourage a widespread transition toward cleaner technologies and support global efforts to mitigate climate change.

292. (A) Evaluating the environmental performance of buildings.
Frameworks for assessing the environmental performance of buildings provide essential standards for sustainable urban development. These systems evaluate how effectively structures use resources and minimize their ecological impact throughout their life cycle. By establishing clear norms, these ratings encourage the adoption of green building practices, helping to improve the overall sustainability of human habitats and reduce the carbon footprint of cities.

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293. (D) controlling pollutants and improving urban air quality.
Implementing stricter standards for vehicular emissions is a key policy measure for improving the quality of the air in cities. These regulations target harmful pollutants like nitrogen oxides and particulate matter, which contribute to smog and respiratory health issues. By progressively tightening these norms, governments can significantly reduce the environmental and health impacts of transport, fostering a cleaner urban environment.

294. (B) capturing and storing atmospheric carbon dioxide.
Reducing the concentration of greenhouse gases in the atmosphere can be achieved by capturing and storing carbon dioxide through various natural and technological processes. This activity, known as sequestration, helps to offset emissions and mitigate the effects of global warming. Whether through planting new forests or using advanced industrial methods, this strategy is a vital component of comprehensive climate change mitigation efforts.

295. (C) promoting resource efficiency and environmental responsibility in the built environment.
Creating sustainable human settlements involves designing buildings and infrastructure that are resource-efficient and environmentally responsible. This focus on the built environment ensures that urban development supports long-term ecological health while providing comfortable living spaces. By promoting green building standards and sustainable habitat practices, cities can significantly reduce their overall environmental impact and move toward a more sustainable and resilient future.

296. (D) Arsenocosis
Prolonged exposure to certain chemical contaminants in groundwater can lead to chronic and debilitating health conditions. In several regions, the presence of arsenic in drinking water sources has been linked to a specific illness characterized by long-term physiological damage. Monitoring and treating water supplies

is essential for preventing these epidemiological issues and protecting the health of populations in contaminated areas.

297. (A) mass poisoning from mercury contamination.
Industrial accidents and the improper disposal of toxic waste can lead to catastrophic mass poisoning events. For instance, the release of heavy metals into the environment has caused severe neurological damage and other health crises in affected populations. These disasters serve as a grim reminder of the profound impact that chemical contamination can have on public health and safety.

298. (B) Inadequate water storage creating mosquito breeding grounds.
The spread of vector-borne diseases is often linked to environmental factors such as poor sanitation and inadequate water storage. These conditions provide ideal breeding grounds for mosquitoes, which can transmit illnesses to human populations. Improving water management and public health infrastructure is crucial for reducing the incidence of these diseases and ensuring a safer and healthier environment for urban and rural communities.

299. (B) Chernobyl and Fukushima Daiichi
Nuclear accidents pose long-lasting risks to human health due to the release of radiological contaminants into the environment. Major incidents at power plants have highlighted the profound dangers of radiation exposure, which can affect vast areas and multiple generations. These events underscore the need for stringent safety standards and international cooperation to prevent future disasters and manage the health impacts of nuclear technology.

300. (A) excessive intake of fluoride.
Certain health conditions affecting the skeletal system and teeth are caused by the excessive consumption of specific minerals found in groundwater. High levels of fluoride intake, for instance, lead to a debilitating condition that impacts the structural integrity of bones. Ensuring access to clean, safe drinking water is vital for preventing such environmental health issues and supporting well-being.

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